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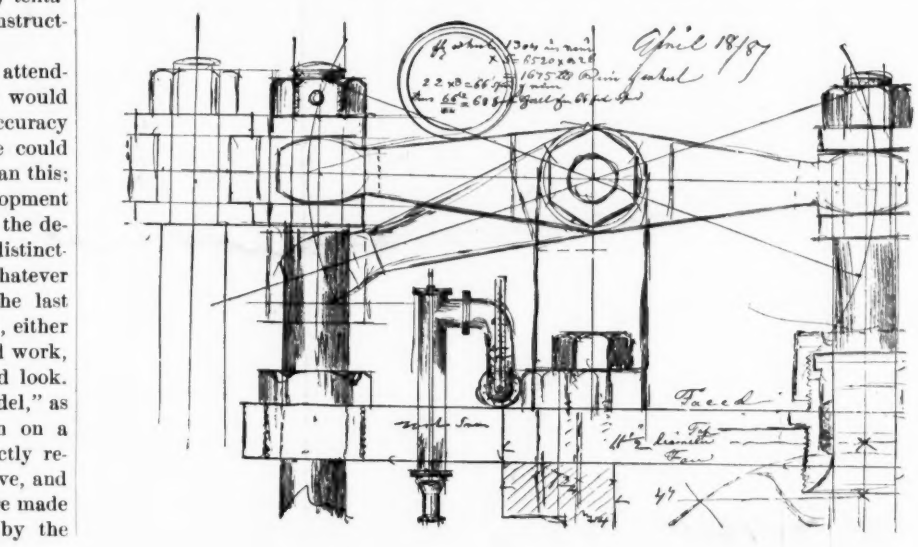
Ericsson's Methods of Work.

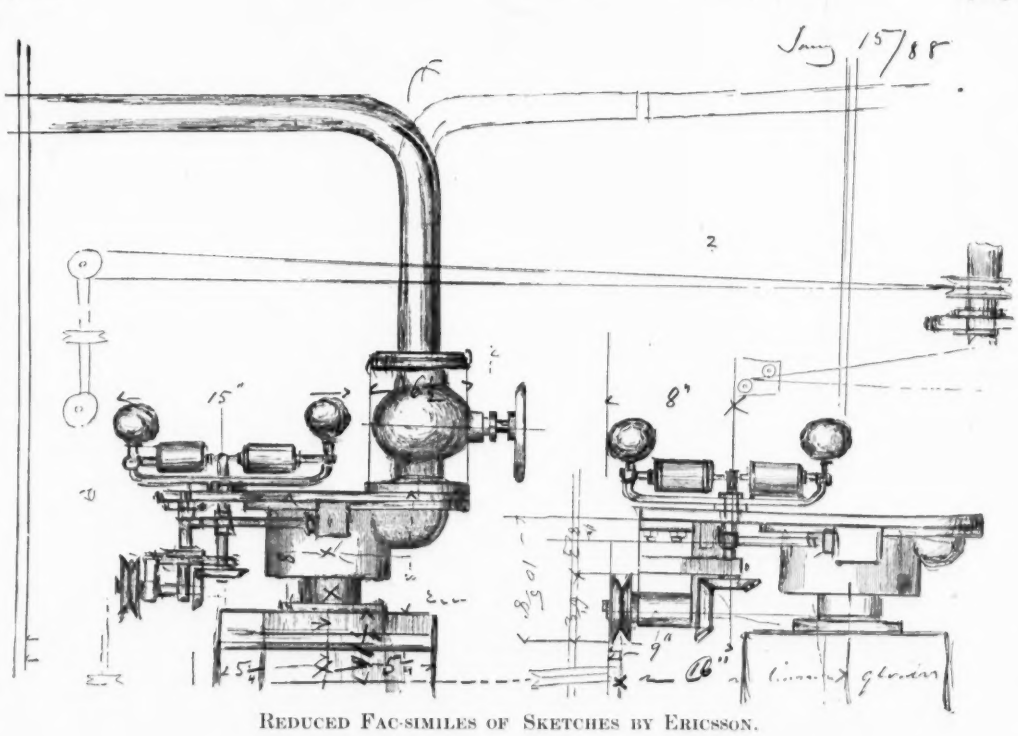
BY PROF. C. W. MACCORD.

In many of the notices relating to Capt. Ericsson, which appeared in various periodicals soon after his death, he was spoken of as passing the most of his time "in his workshop, surrounded by his models and his tools." The picture thus presented to the mind is that of a mechanic of inventive turn, but defective imagination, working by tentative methods, and mainly busied in constructing experimental models.

On account of the haste necessarily attending the production of such notices, it would be unreasonable to expect perfect accuracy in all particulars; but by no chance could anything be farther from the truth than this; for he possessed in its fullest development that imaginative power which enables the designer mentally to see, with perfect distinctness, the form and proportions of whatever he wishes to have made; and was the last man on earth to have need of a model, either to convince him that a scheme would work, or to show him how a machine would look. The popular idea of a "working model," as the first step toward a construction on a practical scale, was in his case exactly reversed; models to be sure he did have, and very beautiful ones too; but they were made after the machines were built, and by the most skillful workmen he could find. When applying for a patent he would frequently order two models, one of which was sent to Washington, while he retained the other—not for his own gratification, since he regarded such things as mere toys—but because they were of use in explaining his designs to others. Let the reader then imagine a large, comfortable, neatly furnished room, with three windows facing the north; at the western end a fireplace (for stoves he would have none); in front of the eastern window a table, upon which were placed his drawing-board, and a few well-worn but well-made instruments, and he will have a tolerably correct idea of the "workshop and the tools" of John Ericsson. And of the models, too, so far as his surroundings were concerned; for none of them were ever kept here, with one temporary exception.

The captain's accomplishments as a draftsman were phenomenal. His beautiful maps early won him great distinction in his native country, and the exquisite finish of colored drawings made later on amply attested his mastery of the brush. But during the last thirty years of his life he did not take the time to put his lines in ink; to use his own words, "I do not make drawings any more; I only make marks." They were not, however, mere general schemes intended to give his assistants an idea of what was to be worked up, but were in reality drawings, complete in detail, with outlines firmly penciled, often shaded here and there to bring out the form of certain parts more distinctly, and accurately laid out to scale; so that, if time pressed, any part could be at once traced and the work put in hand, which was often done, even when finished drawings in ink were subsequently made by his aids. And if crowded for space he did not hesitate to superimpose one view upon another, always provided that the lines of the two were such as not to be confounded with each other; in this way he would often put much more upon a sheet of his "marks" than could be done when it was copied. Some idea of the dexterity with which he manipulated the few instruments which composed his later outfit may be formed from the fact that the portfolio of this work, executed during the last six months of his seventieth year, contained forty-eight double-elephant sheets. It is true that the captain devoted more hours per day to his work than most men do or can, and there is no doubt that his mental store of precedents, gathered during his long previous practice, enabled him to dispense with many computations; but, on the other hand, he conducted an extensive correspondence, he contributed articles to scientific journals, he was much engaged in abstract physical speculations; when all is said, then the fact remains that he produced working drawings with a rapidity probably never surpassed, if, indeed, ever even approached. It is not to be understood that his assistants were all employed solely as copyists; there was plenty of other work for them to do, for which he furnished the groundwork in the form of rough-and-ready sketches and verbal instructions; but the proportion of this was far less than is common among constructing engineers, for which reason the world at large, however well informed as to the number, variety and magnitude of the things he accomplished, has not and never can have any adequate idea of the prodigious amount of labor which he personally performed. Much of this labor he might have saved himself, but he did it from preference. He loved and thoroughly enjoyed the work, for one thing, but besides, he was fastidious in regard to details, of which his arrangement was masterly; in working them out he displayed an inexhaustible fertility, as well as a marked originality, by which his designs are strongly characterized.





REDUCED FAC-SIMILES OF SKETCHES BY ERICSSON.

On putting one of these sheets into the hands of an assistant, Capt. Ericsson invariably accompanied it by explanations which were very models in every way—brief, lucid, and complete. Not a single point was overlooked, and he was not satisfied until it was clearly understood. But it must be comprehended then and there, and it must be remembered, too; once a plan was delivered, he had an intense aversion to repeating the explanation. The same qualities characterized his instructions to those whom he employed to superintend the construction of work in progress; and it hardly need be said that so finished a draftsman was minutely critical as to the execution of plans made for him. The consequence was that he drilled his staff to a high degree of efficiency, so that, with his own mighty shoulder at the wheel, it is probable that, when he was busiest, so much work was never before accomplished with so small a retinue at headquarters. He also insisted rigorously upon having his plans followed to the letter; his drawings were complete to the smallest detail, and he would tolerate no deviation; in which he was clearly right, since the whole responsibility rested upon him. He argued that if an inch were given in this direction, an ell would be taken, and the result would be endless confusion and uncertainty. An amusing incident, illustrating his pertinacity on this point, occurred during the building of one of the larger Monitors. His outside superintendent of this work—a very presuming and conceited individual—came one day with a beaming countenance to report concerning the engine bulkheads. The rate of progress was quite satisfactory, but he could not refrain from stating, with a self satisfied air, that he had had the rivets headed up with a button-set, as he thought that made a better finish. "Ah, indeed!" said the captain, "how many have you put in?" The superintendent pointed out on the drawing how far he had gone. "And they look *well*, do they?" continued Ericsson, to which of course he received an eager and emphatic response in the affirmative. "Very well; now to-morrow you will be good enough to have them all cut out, and replaced by others riveted up with the hand-hammer, with a conical finish, according to the drawing." And this unexpected instruction the crestfallen man was obliged to execute.

The power of forming a clear mental picture of a proposed structure, which all designers must possess in a greater or less degree, would seem in Ericsson to have been abnormal. With nothing to guide him but a sketch upon a small scale, much of it often free-hand, he would furnish full-size detail drawings with astonishing rapidity. And what was more remarkable, it apparently mattered little to him whether they were made in sequence or not; he would send out first whatever was most needed in the shop. If the pattern makers were running short of work he would supply plans for castings, but on a hint that the blacksmiths were idle he would put wrought-iron work in hand. Each piece, too, was complete when he sent it out, and his mastery of detail was seen in the fact that, even when working in this seemingly disconnected way, he allowed nothing to look like an afterthought. It often happened that here a bracket on a cylinder, there a squared collar on a rock-shaft, puzzled the workmen, who could discover no use for it,

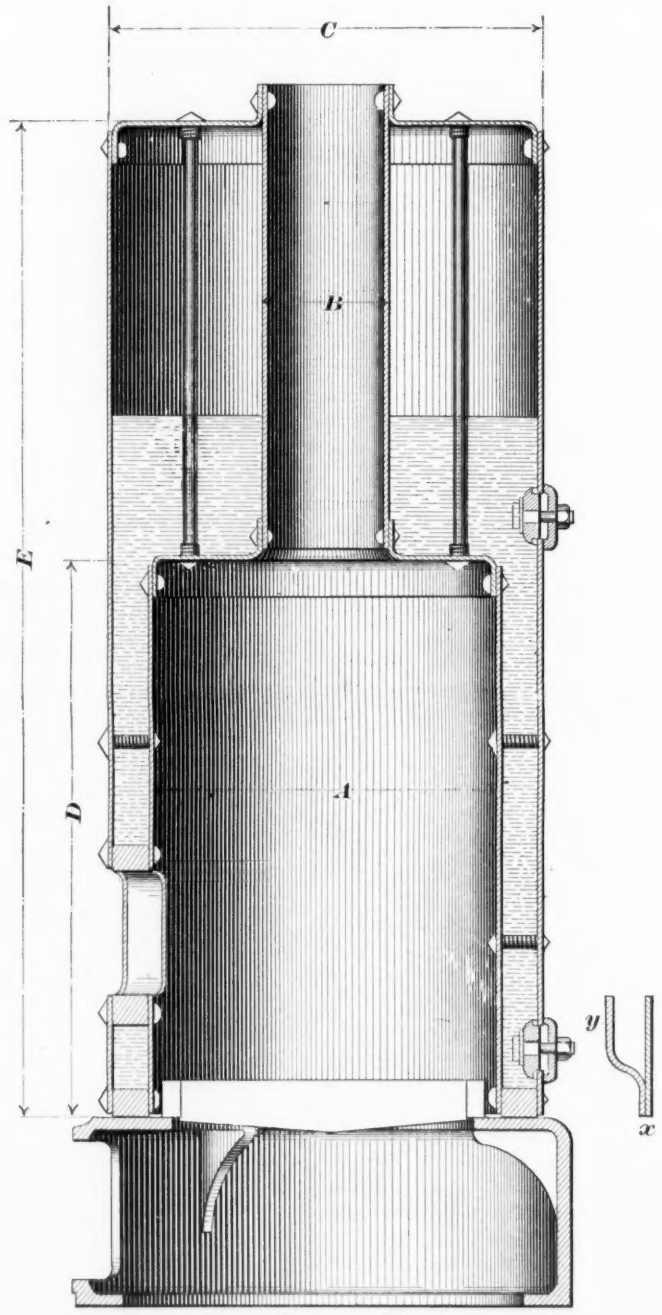
but in the end it invariably proved to have a very evident use, and the parts fitted to it harmonized with the rest of the machine, making the whole structure neat, compact and well-balanced. Thus half an engine might be well under way before the other half was planned, a general drawing of the whole not appearing until the parts were to be assembled in the erecting-shop; and it was this peculiarity in Ericsson's method of work that accounts, in part at least, for the rapidity with which projects under his supervision were pushed to completion. And it was a peculiarity in which he had nothing to fear from rivalry; to secure in this way not only freedom from error in the various members, but also the due relations of form and proportion between them, demands a *persistence* and also a clearness of mental vision, for which we may seek elsewhere in vain.

Now it may be urged that this is not the best way to attain the best results; that it is desirable to have the whole design so far complete before the construction is begun, that a general plan can be furnished for the guidance of the shop superintendent, who, thus knowing what parts are to be fitted to each other, and the relations and functions of all, can direct the work more intelligently, and with greater confidence. This is in many cases very true, of which Ericsson was perfectly well aware, and he adopted that course upon occasion.

Thus, in the years immediately preceding the outbreak of the civil war, numerous applications were made in this and other countries for licenses to manufacture the "Domestic Caloric" engine. The process of blue-printing was then unknown, and the multiplication of tracings became excessively laborious; accordingly, a complete set of plans, general and detail, was made for each of the two sizes of that engine most extensively used; these were lithographed, and a copy of each set was forwarded, with the license, to every new applicant. So, again, when the whole of a small engine or piece of mechanism could be advantageously worked out at once, it would be done; but the course first indicated was his usual one in executing larger or more complicated designs. It is not, however, by any means to be inferred that in all cases a single sketch was made to answer all purposes. When haste was not too urgent, he would in the evenings cover sheets and half sheets of foolscap with supplementary sketches of minor parts, accompanied by notes, comments and calculations; graphic memoranda, which often he alone could use, and not at all such as he would furnish for the guidance of an assistant. In relation to these calculations, it may be said that one factor of his rapidity in designing details lay in his aversion to over-refined formulæ. Quick to distinguish between essentials and non-essentials, he saw that the effect of the "practical coefficient" was substantially to obliterate the minute elements sometimes found in formulæ whose abstract correctness he did not pretend to question; and these he would neglect accordingly. Again, his mind by nature inclined strongly to geometrical in preference to analytical reasoning, and he largely employed graphic methods as the more expeditious, while still giving results of sufficient accuracy for his practical purposes.

Of experimental engines, particularly those actuated by hot air, Capt. Ericsson made a great number; but these were in no sense models. It is easy to see that of two different arrangements, one may be the better in respects and for reasons which can be determined only by competitive trial upon a reasonable working scale, and for a considerable time. Having thus tested one arrangement to his satisfaction, the captain displayed a singular facility in transforming it into another by alteration of details, without affecting the unity of design apparent in the engine as a whole. It was not the question whether the one or the other would work, but which would be practically the better; that decided, and not before, he would be ready for the model and the patent.

He exhibited also an equally remarkable ingenuity, as well as marvelous fertility, in devising the endless variety of mechanical movements which were employed in these and other engines. Many of these are of striking beauty, and all are characterized by the simplicity of the means used to attain the required result; in this field he took the greatest delight, and it was here that his pride in originality was most clearly shown; if the end in view were one which had been reached by others in any way, it would seem that the knowledge of that fact was to him a sufficient reason for seeking a new one. Here, too, he gloried in his mastery of geometric and kinematic principles—no deduction or discussion of equations, no juggling with signs and symbols led him by tortuous paths to a formula that must yet be translated into the graphic tongue; to watch him was a liberal education in this branch—a few rapid twirls of the compasses, a few swift strokes with the pencil, and with incredible speed his scheme was set out, his point was



Small Vertical Boiler.

reached, and as he once declared in round set terms, "What I cannot prove by geometry, I will not prove at all."

In this also he recognized the futility of over-refinement, and the fact that close approximation is often practically as good as absolute theoretical exactness. He saw more clearly than many the difficulty of securing in the actual running, particularly of heat engines, the precise conditions upon which the construction of a movement was based; or at least he treated it with greater deference. The effects of the necessary freedom in fitting of rapidly moving parts; the effects of wear in altering distances by keying up; the unknown and usually overlooked effects of expansion upon the relations of various members, which make a hot engine different from a cold one; these and like things, which might conspire to derange the niceties of a precise movement, were duly considered. Then the proportion that a given deviation would bear to the general result being taken into account, the practical side of his nature asserted itself; he planned engines, not for the mere gratification of mathematical instincts, but to *run*, under ordinary working conditions; and he was not the man to retain an avoidable complication for the sake of an inappreciable advantage.

In nothing, however, was the supremacy of Ericsson so absolute as in the simultaneous management of several different projects; for he possessed in mechanical matters a mental power analogous to that of Philidor and Paul Morphy in relation to the game of chess. Those celebrated players certainly did not conduct a number of games at once by simply remembering, in the usual sense of that word, the various moves which they and their opponents made; nor is it conceivable that any mere mnemonic effort could have enabled the captain to carry in mind as he did not only the details, but the dimensions of several engines in different stages of progress. It was apparently a matter of perfect indifference to him upon which he was engaged; with surprising facility he would drop one and furnish for another any required part, thus advancing the work upon all with equal rapidity, and this without sacrificing in any one of them either the unity or the peculiarity of its own special design. Not that he would trust to his memory, although on these points it was almost never at fault, in relation to those parts which were to be fitted to each other, being by far too cautious for that; about such things he was accustomed to say, "You have no right to *think*, you must KNOW." And, accurate as were both his work and his memory, he avowed that "the easiest thing a man could plan was a mistake," and took especial pains to detect as well as to avoid errors; he never would send out a tracing without most careful inspection, nor without testing it by comparison with its associated drawings. Memory, however, could not have been the chief factor in these remarkable feats, which can hardly be accounted for otherwise than by supposing that there existed in the minds of the chess-players, and the designer, persistent as well as vivid mental pictures of the various boards and the different engines.

It will be perceived, then, that Captain Ericsson for the most part aimed at the greatest possible expedition in completing any given piece of work, and adopted the methods which were most conducive to that end. Some of his most important projects were carried out under circumstances requiring urgent haste; thus, the imagination shrinks from considering what might have been the consequences had the Monitors not been begun until a complete set of plans had been elaborated; and again, in relation to the Spanish gunboats, it is to be recollected that wars are ended too soon in these days of rapid motion to admit of any such dilatory modes of procedure.

But when such pressure was not exerted from without by the very conditions of the case, there was ordinarily an equal pressure from within. What was in hand to-day must give place to something else to-morrow; he worked continuously, not only because he liked to, but because he could not help it. And his selection of his method was not due to vanity on account of his transcendent ability in using it, nor yet to mere impatience of delay, which is a failing of many lesser minds; it was due to the thoughts of projects yet to be accomplished, that filled his teeming brain and pressed forward to realization in their turn. The sluggish stream of the meadows may be content to await the formation of the placid mill-pond, whence stores of power may be drawn at leisure; but the imperial mind of Ericsson was like the rushing torrent of his own Swedish mountains, which, impelled by the resistless force of perennial springs, no obstacle can retard.

Small Vertical Boilers.

There are many different types of boilers suitable for furnishing steam to small engines, and when it is necessary to select a boiler with which the greatest economy in fuel can be obtained, it is often a difficult matter to decide which type to adopt. But when it is only a question of simplicity of construction, a plain vertical boiler, as shown in our illustrations, recommends itself.

The numerous questions we have received relating to the size of these boilers for a given horse-power led us to believe that an article giving the rules for finding the dimensions of a boiler of this type will be of interest.

Let it be required to determine the size of a vertical boiler for an engine of two indicated horse-power. We say indicated horse-power because this generally forms the basis from which the dimensions of a boiler are determined. The indicated horse-power is that shown by the indicator; it takes no account of the power required to overcome the friction of the engine, hence the actual horse-power which the engine can develop will be equal to the indicated horse-power minus the power required to overcome the friction; the latter may be taken at 15 to 20 per cent. of the indicated horse-power for small engines. In the following remarks we shall take only the indicated horse-power in account, and for the sake of brevity will simply call it the horse-power. Hence our problem is to find the size of a plain vertical boiler for a two horse-power engine.

Our first step will be to find the number of square feet in the grate surface. The grate surface depends on the amount of coal to be burnt, and this amount is generally dependent, to a large extent, on the quality of the coal, and also on the type of engine which takes steam from the boiler, and whether natural or forced draught is used. We shall assume that bituminous coal is to be used, with natural draught.

For small engines we believe that 10 pounds of coal per horse-power is a fair allowance, consequently for two horse power we shall need to burn 20 pounds of coal every hour. On every square foot of grate in this

type of boiler we may expect to burn eight pounds of bituminous coal per hour per square foot of grate with natural draught, and, since we need to burn 20 pounds on the whole grate surface, we need $\frac{20}{8} = 2.5$ square feet; and a furnace that can admit 2.5 square feet of grate surface will have to be nearly 22 inches in diameter; this diameter we shall adopt; it will give us 2.63 square feet of grate surface instead of 2.5 square feet.

Our next step will be to find the diameter of the flue. The cross-sectional area of the flue should be one-eighth of the grate surface. We have 2.63 square feet of grate surface, hence the cross-sectional area of the flue should be $\frac{2.63}{8} = .328$ square feet, and the corresponding diameter will be nearly $7\frac{3}{4}$ inches, which is the inside diameter of the flue. These flues are generally made of lap-welded boiler flues, and the nearest size that can be obtained in the market is a flue eight inches outside diameter.

We shall now find the height of the furnace. This height will depend on the amount of heating surface. The usual practice is to allow for large stationary boilers from 25 to 32 square feet of heating surface for every square foot of grate surface; this heating surface includes the tube or flue surface, which is not as valuable as the heating surface in the fire-box, or that directly exposed to the fire. It must also be remembered that in large boilers about 15 pounds of bituminous coal are burnt on one square foot of grate surface. We have seen that in these small vertical boilers only about eight pounds of coal per square foot of grate are burnt, and it must also be noticed that nearly all the heating surface is in the furnace; it is therefore, in comparison with the heating surface in multitubular boiler, more efficient than in the latter class of boilers. We shall allow in these small vertical boilers about nine square feet of heating surface for every square foot of grate surface. About one-quarter of the heating surface is in the flue, therefore about seven square feet of heating surface per square foot of grate are required in the furnace, and this proportion we shall adopt. We have 2.63 square feet of grate, hence $2.63 \times 7 = 18.41$ square feet, which is the amount of heating surface in the furnace. Subtracting the area cut out of the crown sheet for the flue from the area of the crown sheet, we obtain the heating surface which the crown sheet contains. The total area of the crown sheet (1 foot 10 inches diameter) is 2.63 square feet; the cross-sectional area of the flue eight inches diameter is .34 square feet; we have, therefore, $2.63 - .34 = 2.29$ square feet of heating surface in the crown sheet. Subtracting this surface from the total heating surface required in the furnace, namely, 18.41 square feet, we obtain the number of square feet in the cylindrical part of the furnace above top of grate. We say above the top of grate because from this line the heating surface is reckoned. Consequently the number of square feet of heating surface in the cylindrical part of the furnace will be $18.41 - 2.29 = 16.12$ square feet. We have already found that the diameter of the furnace is to be 1 foot 10 inches; its circumference will be 5.75 feet. Now dividing the heating surface of 16.12 square feet by the circumference we have $\frac{16.12}{5.75} = 2.8$, say two feet nine inches, for the height of the furnace above the top of grate. Allowing three inches for the depth of grate, we have $2' 9'' + 3'' = 3$ feet for the total height of furnace from the bottom of the boiler. Here we have neglected the small surface cut out for the door, but we have taken the inner surface of the furnace for the heating surface. Some engineers take the outer surface; the difference will be in favor of the boiler.

For two and three horse-power boilers the water space around the furnace should be not less than $2\frac{3}{16}$ inches. The thickness of the furnace sheet is $\frac{5}{16}$ths of an inch, and the thickness of the outer shell is one-quarter of an inch; these dimensions will give us a distance of $\frac{5}{16}'' + 2\frac{3}{16}'' + \frac{1}{4}'' = 2\frac{5}{8}$ inches from the inner surface of the furnace to the outer surface of the shell. The inner diameter of the furnace we have found to be 1 foot 10 inches (22 inches), hence the outside diameter of the shell will be $22'' + 2\frac{3}{4}'' + 2\frac{3}{4}'' = 27\frac{1}{2}$ inches.

It now remains for us to find the total height of boiler. The distance from the outer to the inner crown sheet over all is to some extent arbitrary; we must have a sufficient water and steam space, and these requirements are generally satisfied by making the distance from crown to crown equal to 80 per cent. of the height of the furnace. The total height of the furnace is 36 inches, hence $36 \times .80 = 28.80$ inches from crown to crown over all—here we may neglect the fraction, and call it 28 inches; consequently the total height of the boiler will be 36+28=64 inches. The dimensions of boilers given in the following table have been determined by the foregoing rules. This type of boiler is not the best one for economy in fuel, but on account of its simplicity it recommends itself, and is often used for small horse-powers, and also for such cases in which steam is required only at intervals. For services of this kind the waste of fuel will not be much felt; and, on the other hand, the first cost of the boiler is comparatively low, and all its parts can be inspected with greater ease than those of other types of boilers.

It is of the utmost importance that boilers should be kept free from incrustation, at least not over the thickness of a piece of paper; and the collection of mud and scale, which is sure to take place around the bottom of the furnace in this type of boiler, and also on the furnace crown sheet, must be avoided; it is therefore necessary to provide each boiler, even the smallest one, with at least three hand-holes at the bottom, and one or more just above the crown sheet; the hand-holes should be not less than 2x3 inches, so as to provide easy means for cleaning and inspection. Plugs one inch or $1\frac{1}{4}$ inch in diameter instead of hand-holes should not be used; they are not large enough, the thread is liable to give trouble, and the plugs may become decidedly dangerous. When these boilers are used for heating purposes, and the pressure does not exceed five pounds per square inch, the stay bolts shown in the illustration are sometimes left out. For higher pressure the stay bolts are, of coure, required, and their number will depend on steam pressure to be carried. We have shown screw stay bolts; when these are used their number should be such that the stress per square inch will not exceed 6,000 pounds per square inch at the smallest cross-section; that is, the section at the bottom of the thread. Screw stay bolts answer their purpose when fresh water is used for generating steam; but when salt water is used the Board of Supervising Inspectors of steam vessels do not permit them to be employed; they must be plain stay bolts riveted over, passing through ferrules placed between the sheets.

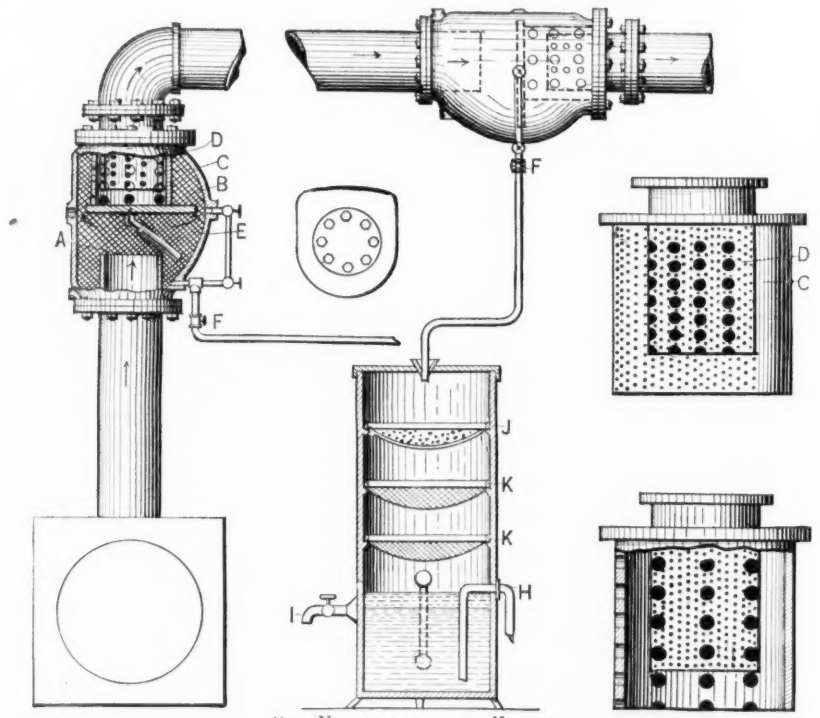
Sometimes the connection between the bottom of shell and furnace is made by placing a wrought-iron ring between them, the rivets passing through the ring, outside sheet and furnace sheet. When the ring is not used the furnace sheet is flanged as shown at *x*. In either case the grate bars should be placed high enough to prevent the furnace sheet from being burnt in case a collection of mud has taken place in the water space before it has been detected.

The ring around the fire-door is sometimes made of cast-iron; we recommend wrought-iron.

For small boilers up to four horse-power inclusive, the shell should be $\frac{1}{4}$ inch thick; fire-box, $\frac{5}{16}$ inch; outside heads, $\frac{3}{8}$ inch, and inside head $\frac{5}{16}$ inch thick. For the larger boilers the thickness of shell should be $\frac{1}{4}$ inch thick; furnace, $\frac{5}{16}$; outside head, $\frac{7}{16}$ inch, and inside head $\frac{7}{16}$ thick.

Shell to head single-riveted; diameter of rivets, $\frac{3}{4}$ inch; pitch, $1\frac{3}{4}$ inch. Longitudinal seam of shell double-riveted; diameter of rivets, $\frac{3}{4}$; pitch, $2\frac{1}{8}$ inches; distance between the two rows of rivets, $1\frac{9}{16}$ inch. In the furnace all the seams should be single-riveted; diameter of rivets, $1\frac{1}{16}$ inch; pitch, two inches. The pitch here given for the different seams is suitable for wrought-iron plates whose tensile strength is about 45,000 pounds per square inch. For a greater tensile strength the pitch can be decreased. It is also assumed that the rivet holes have been punched, and the plates not annealed after punching. The reason for this remark is that in punching wrought iron plates they lose some of their tenacity along the line of rivet holes, caused by squeezing the metal around the hole beyond the limits of elasticity, thereby weakening the sheet. In annealing the plates their original tenacity will be restored. Experiments also indicate that rivets in drilled holes will shear with less pressure than those in punched holes, which is probably due to the sharp edges of the drilled holes. For determining the correct pitch all these items should be considered. The pitch here given agrees with the average practice in boiler construction.

The rivet holes in the furnace should be countersunk on the inside to a depth of one-third of the thickness of the plate, and the rivets driven from the inside, forming a shallow button-head. When made in this way the rivet heads are not so liable to burn off.



OIL EXTRACTOR AND FILTER.

DIMENSIONS OF PLAIN VERTICAL BOILERS.

Horse Power.	Inside Diam. of Furnace *A.*	Outside Diam. of Flue *B.*	Outside Diam. of Shell *C.*	Height of Furnace *D.*	Height of Boiler *E.*
2	22″	8″	$27\frac{1}{16}$″	36″	64″
3	27″	9″	$32\frac{5}{16}$″	44″	79″
4	31″	11″	$37\frac{1}{16}$″	51″	91″
5	34″	12″	$40\frac{5}{16}$″	55″	99″
6	37″	13″	$43\frac{9}{16}$″	59″	106″

New Oil Extractor and Filter.

With this we give illustrations of a new oil extractor and filtering apparatus, devised and now being brought to the notice of engineers by Hine & Robertson, of 45 Cortlandt street, New York City.

At the left of the cut is shown its application in a vertical position, the course taken by the steam in passing through it being indicated by the arrows. The exhaust pipe opens into the chamber, and the steam striking the deflector plate above the opening is thrown out to the sides, and passes through the perforated cylinders, of which there are two, one inside the other. The oil and water which have been carried along with the steam up to this point will have to be separated, and, falling upon the upper side of the deflector plate, pass down through the drain pipe shown, and into the annular space surrounding the upper end of the exhaust pipe, from which they are drained by the small pipe shown, into the filter. This pipe is provided with a valve, which is kept open just sufficiently to keep the oil and water drained off, or, where the plant is sufficiently large to warrant the expense, a small trap can be provided.

At the right of this, its application in a horizontal position is shown; its action here being much the same, except that the mixed water and oil gather in the extension of the chamber below the ends of the exhaust pipe.

Below is shown the filter, which consists of perforated metallic pans, the two lower ones having filtering cloth placed in them. These remove all sediment and impurities, and the oil finally rests on top of the water, at the bottom of the filter, from whence it is drawn off by the cock *I*. The siphon *H* is so arranged that it automatically draws off a portion of the water whenever it rises sufficiently high to fill the tube, but as it reduces the level only to the height of the lower extremity of the outer leg, oil never gets into it, but can only be drawn off by means of the cock.

Enlarged views of the perforated cylinders are shown at the right of the filter, one having comparatively large holes in the inner cylinder, and small ones in the outer one, while the other shows the alternate arrangement.

The facility with which variations of this kind, or in the number and size of the perforations in the cylinders can be made, is one of the special advantages claimed for this extractor, because it can thus be readily adapted to secure the best results under varying conditions as to back pressure, etc. An uncommonly large one is to be put in at the new sugar refinery of Claus Spreckles, at Philadelphia, where the exhaust steam is being used for heating the vacuum pans; 10 pounds back pressure is maintained. The exhaust pipe is, in this instance, 20″ diameter. The extractors will be made of any size to suit circumstances.

Some students of Stevens Institute came over to New York a few nights ago, and, when returning to the other side of the river by ferryboat, gave a practical illustration of dynamics, by smashing windows in the ladies' cabin, and frightening two ladies into hysterics.

They succeeded in instituting quite a respectable riot—for boys—and some of them were, on touching the Jersey shore, brought into contact with potential energy, in the shape of policemen, who placed them under arrest.

It is stated that the ferry company refused to prosecute, and consequently the *young gentlemen* got off much more easily than if they had been learning engineering in some machine shop instead of in a school, though just why they should we cannot explain. Of course it is well known that boys will be boys, and that students must have their fun. But it would seem to be no more than fair that, when they do have their fun, they should take all that goes with it, the same as other people who start in to have fun

The ferry company owes it to its patrons to maintain order on its boats, and has no more right to encourage rowdyism by students than by other people.

Designing a Toggle Joint Press.

BY WILLIAM KENT.

The AMERICAN MACHINIST of February 20th contains a mathematical investigation of the principles of the toggle joint. In connection therewith, a practical illustration of the use of these principles in designing an actual toggle joint press may be of interest.

Some three years ago the writer had a problem presented to him which required the design of an apparatus of some kind which would give a very great pressure through a small distance. The work to be done was to increase by .03″ or .04″ the length of a piece of metal, malleable cast-iron or brass, originally about half an inch square, and five-sixteenths of an inch thick, by compressing the metal in the direction of its thickness. It had been done experimentally by striking it repeatedly with an ordinary pening hammer; but, as the surface was to be polished and nickel-plated before expanding, the use of a hammer was objected to, on account of the dents it made, and the liability of cracking off the nickel-plating. As the pieces were to be made by the thousand, the hammer was further objectionable on account of the time taken by the workman on each piece, and the consequent high cost of the operation. Some more mechanical method of doing the expanding had therefore to be contrived, and, as there was still some doubt as to the marketability of the thing to be made, it was desired that the apparatus should be constructed as cheaply as possible, and at the same time be strong enough to do the work with certainty and rapidity.

The first question raised was, how much pressure is needed to compress the metal beyond its elastic limit and cause it to flow? The area to be compressed is one-half inch square, equal to one-quarter square inch. The compressive strength of malleable cast-iron, or of brass of uncertain composition, is not exactly known, but it is somewhere in the neighborhood of 100,000 pounds per square inch. This would require a pressure of 25,000 pounds to be used. Possibly drop-forged steel may be substituted some day for the malleable iron or brass, and a quarter pressure might be added; and for this reason, as well as to be sure that the machine would be strong enough, it was concluded to design it so that a pressure of 100,000 pounds could be obtained by it if possible.

The analogy of the process to that of the coining presses used in the United States mint at once suggested that a toggle joint press was the proper kind of machine to use. A hydraulic press was out of the question, on account of the expense of pumps, accumulators, etc., as well as on account of the elasticity of its action, due to the air compressed with the water or other liquid used. Screws and cams were objectionable, on account of the friction and the amount of gear needed to operate them. A toggle joint was exactly what was needed, for it gave an opportunity of exerting a tremendous pressure through a very short distance, and an increasing pressure as the arms were brought more nearly in line with each other.

Having decided on a toggle joint press, the next step was to consider the geometry of the machine, without reference to its actual dimensions. The total distance to be moved through by the movable block at the lower end of the press was taken as one-quarter inch, to allow for possible variations in the thickness of the metal to be used, and to give the press a wider range than was actually necessary, so as to make it available for other uses than that for which it was designed.

As a toggle joint does not become a very powerful press until its two legs make only a small angle with a line joining their extremities (the angle *B D H* in the cut, Fig. 1, in the issue of the AMERICAN MACHINIST, Feb. 20, page 7,) it was decided to make the maximum value of this angle 9 degrees. From a table of natural sines, it is found that the sine of this angle is .1564, and its versed sine is .0123 for radius unity. That is, if the leg *D B* is 10 inches long, the distance *B H* is 1.56 inches, and the distance *D H* is 0.123 inch less than 10 inches, and the travel of the block *D* is equal to twice 0.123 inch, or .246 inch, practically a quarter of an inch.

At this maximum angle of 9 degrees, if each leg of the toggle is 10 inches long, the distance *B H* moved through by the knuckle joint *B*, before the legs come in line with each other, is 1.56 inches, while the distance traveled by the movable block *D* is only ¼

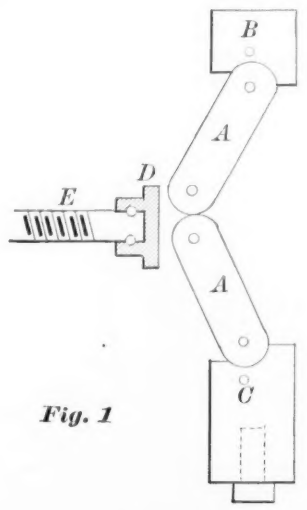
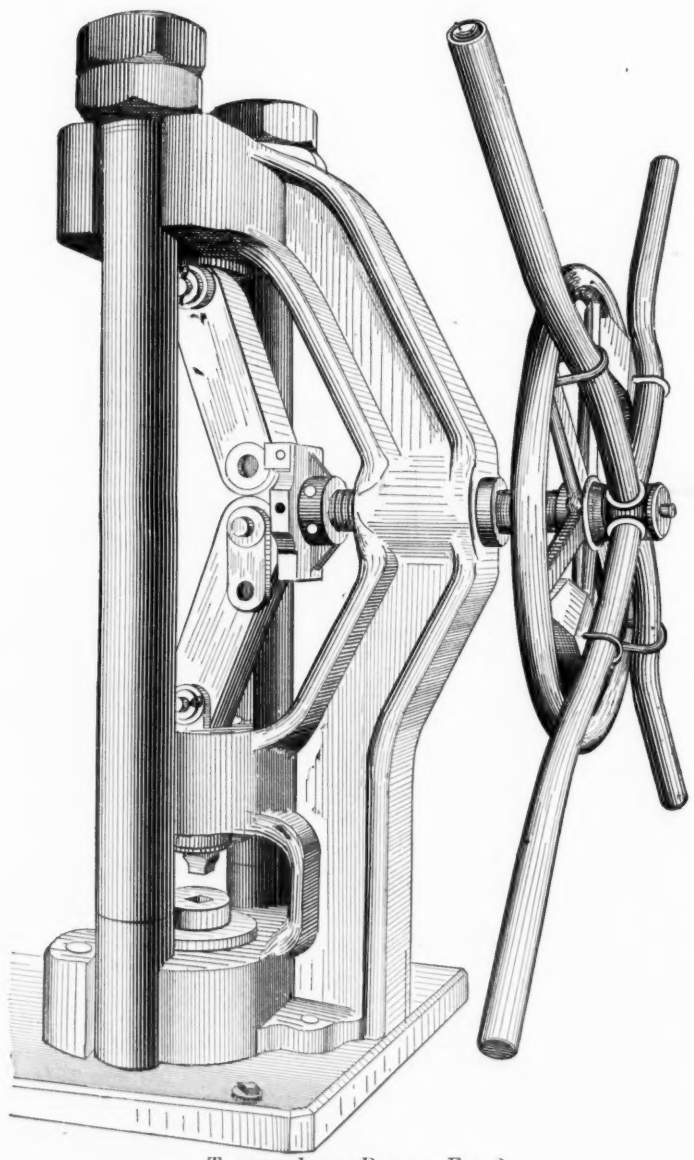


Fig. 1



TOGGLE JOINT PRESS.—FIG. 2.

inch, or about one-sixth as much. The *average* pressure exerted by the block during its whole travel would be six times the force applied at *B* in the direction *B H*, if friction is not considered. As shown in the mathematical discussion of the principle of the toggle joint, however, this ratio of pressure to force is not uniform, but increases toward a theoretical maximum of infinity, as the angle *B D H* decreases towards zero.

Theoretically, considering an ideal and geometrical toggle, the pressure exerted by the block *D* is infinity when the angle *B D H* becomes zero; but practically, an infinite pressure can never be reached, on account of the elastic stretch of those parts of the machine which are subjected to tensile strain, (the bed plate in Fig. 2), and the elastic compression of the legs of the toggle.

In the particular machine under consideration it was desired that an average pressure of 100,000 pounds should be exerted during the last two-hundredths of an inch of movement of the sliding block *D*.

Referring to the table of sines again, it is seen that the sine of 3 degrees is .0523, and the versed sine is .0014″. The legs being 10 inches long, the travel of the knuckle joint, while the angle *B D H* is reduced from 3 degrees to 0, is .523″, say half an inch, while the travel of the block is double the versed sine, multiplied by 10 inches, or 0.028 inch. The block then travels only $\frac{0.028}{0.5} =$ about $\frac{1}{18}$th as far as the knuckle joint. For a slightly smaller angle than 3 degrees, the travel of the block would be $\frac{1}{20}$th of that of the knuckle, and the average force required to push the knuckle inwards would be $\frac{1}{20}$th of 100,000 pounds, or 5,000 pounds, friction not included.

For the purpose of applying this 5,000 pounds pressure, plus what may be needed to overcome friction, a screw operated by a hand-wheel is immediately suggested, on account of its simplicity.

A screw with 5 threads to the inch would have to move through 2½ revolutions to advance the knuckle ½ inch. The rim of a hand-wheel of 20 inches diameter, say 62.8 inches circumference, would travel 157 inches while the knuckle advanced ½ inch, or 314 times the distance advanced by the latter. If there were no friction, the force required to be exerted on the rim of the wheel would be $\frac{5000}{314} = 16$ pounds. Screws and toggle joints are notorious for the amount of frictional resistance they give rise to, and their friction is a variable quantity, varying with tightness of fit, smoothness of surface, character of lubrication, etc. A large element of guesswork is here needed, and it is guessed that the friction is three times as great as the amount of useful work, or that only one-fourth of the work exerted at the rim of the wheel will be transmitted to the pressure block. This would require a force of 64 pounds instead of 16 at the rim of the wheel, and as that is a rather large amount for a man to exert without fatigue, it may be reduced by increasing the diameter of the wheel, or by attaching arms radially to the rim, which may be as long as the radius of the wheel. The pressure to be exerted at the end of the arm then would be 32 pounds.

The geometry of the design is thus completed, and it comprises two toggle legs, each 10 inches long, a maximum angle of 9 degrees, a minimum of 0, and a screw to work the toggle, with 5 threads to the inch, and a hand-wheel and arms attached, of a radius of 20 inches.

We now have to consider the actual dimensions of each part, so as to design a practical machine which will not destroy itself when it is attempted to be used to its maximum capacity.

First, the toggles. These must be stiff enough not to bend under strain, must have such sectional area that a pressure of 100,000 pounds on the end of them will not sensibly compress them; must have ample bearing surfaces at the joints, so that they may be lubricated, and not squeeze the lubricant out, and cut themselves or their bearings, and, as the whole machine is somewhat experimental, must not be expensive.

A three-inch square bar of tool steel fulfills the first two conditions completely. Assuming a compressive strength of 100,000 pounds per square inch, and a sectional area of 9 square inches, there is a factor of safety of 9. Assuming a modulus of elasticity of 30,000,000, the compression is found by the formula $C = \frac{P\,L}{E\,K}$, where C is the compression, P the pressure, L the length, E the modulus, and K the sectional area.

$$C = \frac{100{,}000 \times 10}{30{,}000{,}000 \times 9} = \frac{1}{270} \text{ of an inch,}$$

or, as there are two toggles, total compression equals $\frac{1}{135}$ of an inch, which is not too great.

To fulfill the third condition, and give ample bearing surfaces, it is seen that pin joints, like those shown in Fig. 1, will not answer, as the pins would be apt to shear or bend, unless they were made too large in diameter to go into the three-inch square bars. Pins are therefore dispensed with, and the outer bearings are made by the ends of the bars themselves, which are rounded off in the shape of a semi-cylinder. The bearing is thus made the whole area of the largest semi-cylinder, which can be cut on the end of a 3-inch bar, and has what is called a projected area of 9 square inches. This gives 11,000 pounds pressure per square inch, which is rather heavy for good lubrication; but as the motion is extremely slow, and intermittent, and the bearing is easily accessible, it is considered sufficient.

The bearings into which these ends abut are next considered. An easy way of making them is discovered. A block of cast-iron is taken, and a 3-inch hole bored in it very carefully, and it is cut in two. Each half makes a bearing for one of the toggles.

The knuckle joint is the next difficulty. Here it is decided to avoid sliding friction, and substitute rolling friction. The ends of the toggles are rounded exactly like the other ends, and the two butted against each other, so that one rolls on the other. There are no exact data accessible for proportioning rollers; but since knife edges on large scales and testing machines have been used under a strain as great as 10,000 pounds to each linear inch of edge, it is supposed that two cylindrical surfaces of tool steel, 3 inches diameter and 3 inches long, will stand a pressure of 33,000 pounds per inch of their length, without one biting into the other.

Here, then, is the arrangement of the two toggles and their bearings. If it should be found that the bearing surface of one toggle on the other, when they are subjected to great pressure, is so great that one may crush the other, the trouble may be remedied by increasing the radius of curvature of the abutting ends, or by making new toggles with greater width, giving a longer line of contract.

The lower block is made long, so that it will act as a slide on the bed plate, and also as a holder of the hardened steel piece, which is the presser block. Means for applying the pressure against the toggles are now to be provided. This is done by means of a flat plate *D*, Fig. 1 (this page), attached to

the end of the pressure screw *E* by two pins. This pushes the toggles inwards, and, as it does so, it slides on their rounded surfaces. As the pressure at the points of contact with the plate is far less than that of the toggles upon each other, there need be no fear that this pressure can do any damage. To diminish the friction between the end of the screw and the pressure plate, a couple of hard steel washers or liner pieces are inserted between them, which may rub on each other with less friction than that of the end of the screw against the plate.

Holes ¾ inch diameter are bored in each end of each toggle, and in each of the bearing blocks, in which pins are inserted, and these pins are connected by links on each side, so that the toggles may be held in proper place. A claw on each side connects the plate which presses against the toggles, and the link in front of it, which joins the ends of the toggles, and this serves to pull back the toggles, and thereby raise the lower block *C*, when the motion of the screw is reversed.

The screw is made of steel two inches diameter, and, when the square thread is cut in it, the smallest diameter is 1.6 inches, area two square inches, which is abundantly large to resist both compressive and torsional strains. The bearing area of each thread surface is about one square inch, or five square inches per inch of length. A nut four inches long would give 20 square inches, which, for a possible pressure on the screw of 20,000 pounds, gives a pressure per square inch of thread bearing surface of only 1,000 pounds, which allows of easy lubrication. This length of nut also presents 10 square inches to resist shearing strains tending to strip the thread, or 2,000 pounds per square inch if there should be a possible strain on the screw of 20,000 pounds. This gives apparently a very large factor of safety; but as there would not be a uniform strain on each thread unless the screw was a perfect one, which is practically impossible, the length of the nut is considered none too large. The nut is made of bronze, as a bushing, which may be replaced if it should wear.

It now remains to construct a frame for the whole machine, and this is simply a heavy casting of I section, with web five inches long, and flanges four inches wide, and one inch thick, carrying at the upper end a heavy block, to which is fastened the block *B*, at its middle the nut, and at its bottom two big lumps, one of which is bored for the cylindrical slide *C*, and the other, six inches beneath, contains the lower pressure block. No matter how heavy this casting may be made, within any reasonable limits, it will spring badly under the heavy strain of the toggles, and therefore the two ends of the casting are connected by heavy steel bolts in the line of strain. These bolts are nearly four feet long, and as they are intended to take the whole longitudinal strain from the casting, they must be designed for a strain of 50,000 pounds on each, and as the whole range of the machine, when under the strain of 100,000 pounds is only to be .02 inch, the stretch of the bolts is the chief difficulty. Steel bolts 3¼ inches diameter were selected, having a total area of 16.6 square inches. From the formula already given,

$$\text{stretch} = \frac{P\,L}{E\,K} = \frac{100{,}000 \times 48}{30{,}000{,}000 \times 16} = \frac{1}{100}$$

inch. The stiffness of the casting will help to reduce this somewhat.

The cut, Fig. 2, is taken from a photograph of the machine, as actually constructed, one of the claws connecting the pressure plate to the links joining the toggles having been removed, and the pin at the upper end of the link taken out, so as to show the bearing of the toggles against each other. The maximum angle of the toggles was made over 30 degrees instead of 9, in order to allow plenty of space for withdrawal of the pieces pressed, and to give the machine a greater range. It has now been in use for two years, several thousand pieces having been compressed in it with the utmost facility. It was a little stiff in working at first, but since the bearing surfaces have worn smooth, they have worked much easier. It is not a handsome machine—in fact, I think it ugly and clumsy—but in building it, economy of first cost was essential, and looks were therefore sacrificed. It is an eminently satisfactory machine for the purpose for which it is intended.

New 22-inch Post or Wall Drill.

Messrs. Boynton & Plummer, of Worcester, Mass., have just brought out a new 22-inch post or wall drill, illustrated by the accompanying cuts.

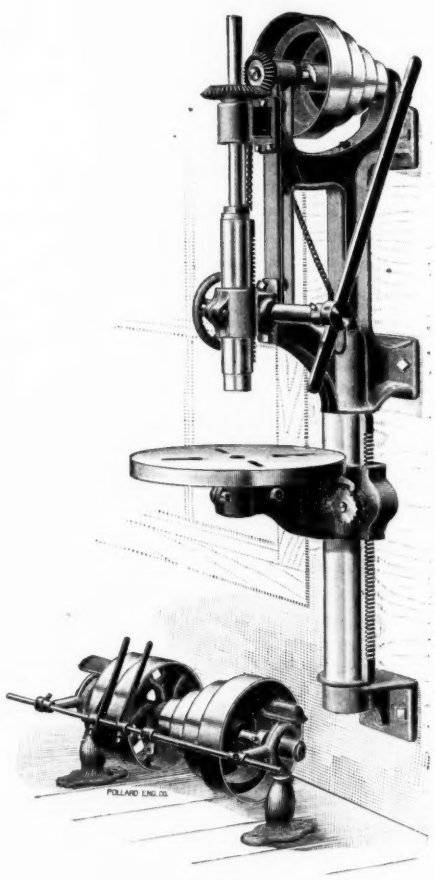


FIG. 1.

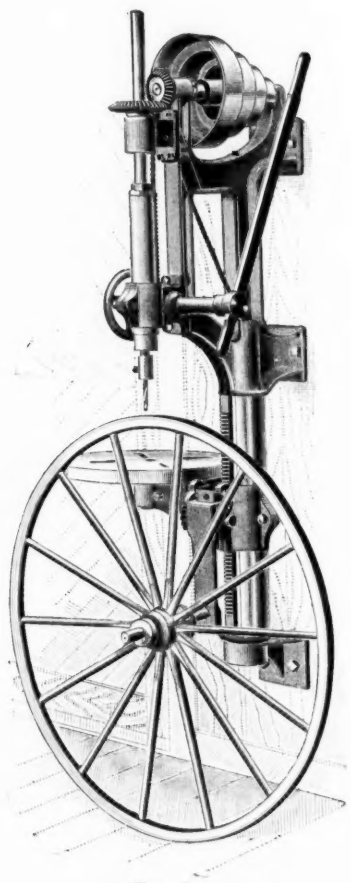


FIG. 2.

22-INCH POST DRILL.

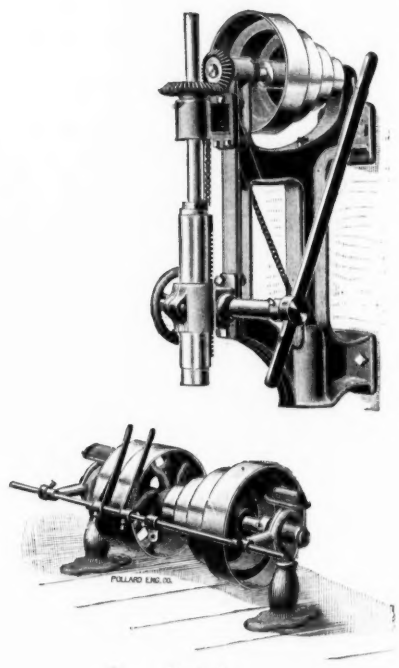


FIG. 3.

Fig. 1 shows the machine as adapted to the ordinary machine shop use. It is strongly braced, so as to prevent springing when being put in position, and, having strong, heavy brackets, is very rigid when fastened to wall or post.

It occupies very little space compared with its capacity, being but 28½ inches from wall to front of table, a very desirable feature in many places where room is valuable.

It is furnished with screw and wheel feed combined, or singly. It is fitted with a simple device for operating the feed lever, by which the lever can be instantly lengthened or shortened, and, when so shortened, the lever can be used for quick return. This, they claim, is a desirable feature, as all the movements of screw feed, lever feed and quick return can be operated on one side of the machine, the lever feed never being locked to shaft in such a manner as to prevent the instant operating of quick return.

They are fitted with large four-step cone pulleys (11″, 8¾″, 6¼″, 4″), for 2¾″ belt. Pulleys on countershaft are 10″ diameter for 3-inch belt. The table is 19″ in diameter, and slotted for fastening work.

The hole in spindle (which is of steel, and properly counterbalanced) is fitted for Morse taper socket No. 3, although sockets for taking chucks or straight shank drills are furnished when desired. Table has a movement of 18 inches. Traverse of spindle is 10 inches. Greatest distance from spindle to table is 23½ inches. Weight complete, 500 pounds.

Fig. 2 represents the drill as adapted to blacksmith and carriage makers' use, being provided with a removable wheel-holding attachment, on which wheels are revolved when drilling holes in tires. This attachment, being fastened to the table, can be fixed at any height to suit various sizes of wheels.

Fig. 3 illustrates the drill as arranged for an overhead or hanging drill. When placed on a cross-beam or hanging post, work of any dimensions can be brought under it.

This machine as so arranged will be found a very valuable tool in many instances.

Figs. 2 and 3 in other respects are the same as Fig. 1.

A Mill Pond of Warm Water.

The owners of a grist mill in Wisconsin keep the water in their mill pond warm the entire winter. Now this may seem incredible, and some of our readers may ask why they don't wash in the house in the winter. Nevertheless, the Upham Manufacturing Co., of Marshfield, Wis., keep the water in their mill pond warm so they can float logs in it during the cold winter days, and run their saw-mill.

The works of the company include a saw-mill, a grist-mill, and a furniture factory of large proportions. The quantity of steam required to run all these works is very large, and the exhaust steam, of which there is considerable, is not allowed to go to waste, but is used to warm the water in the mill pond.

All the exhaust steam from the different sources is passed through a box into which water is allowed to fall through a perforated cover in sufficient quantity to condense the steam and form a fair-sized stream of water. This is conducted to the pond, and as it is warm the tendency is for it to remain on or near the surface. It spreads out over the entire surface of the pond, and being constantly replenished, ice is prevented from forming. Of course this is only possible in still water. The pond in question is artificial, the logs being brought to it by rail.—*American Miller.*

In a recent report of the penitentiary of Pennsylvania, it is stated that, of the 1,060 men confined in that prison, only 19 were bred mechanics.

The inference, which is too plain to be missed, is that men who are trained to work seldom become criminals. There is a good deal of significance in these figures, and a good deal of truth in the conclusion reached. Work, especially manual labor, is the great preventive against mischief and crime. The old nursery couplet about the employment which Satan furnishes for idle hands is quite true. Men who have been reared in idleness often turn criminals. Men who have been educated in the learned professions sometimes become criminals. But men who have been taught a useful trade, and have learned to support themselves by the labor of their hands, very seldom appear in the criminal records.—*Richmond Mercantile and Manufacturing Journal.*

LETTERS FROM PRACTICAL MEN.

More About Grindstones.

Editor American Machinist:

I agree with "A Mechanic" when he says: "I think grindstones have not been well tried in most places." In the industrial world the grindstone and the emery wheel has each its own field, in some parts of which there is no dispute as to which has possession; but tool grinding in a machine shop is disputed ground, and each has its adherents and advocates. I say "fair play is bonnie play," and let us give each a fair chance, which the grindstone has never had, while the emery wheel has been chosen with reference to the work it has to do, is mounted on a substantial iron frame, is well belted, and is driven at a speed calculated to give the best results. It is, however, not so with the grindstone. It is taken without any reference to its hardness or softness, to its coarseness or fineness, to the dullness or the sharpness of its grit, or to the equality of its texture. If it is anything that will at all answer to the name grindstone, it is sufficient. The whole mounting of a machine shop grindstone is generally utterly barbaric. The frame, the axle, the pulley, the belt, are not the objects of thought and care. If it runs out a little, either edgeways or sideways, it is held to be of little consequence; and a stone that is set up so badly, will, of course, always be kept up badly. It will get cut into ruts and holes, till no man can tell on what part of a tool he is grinding, and till no one will use the stone till he is driven to it by sheer necessity; and when one has been so driven, and has done his best to get a tool in working condition, his look of disgust tells how little he is pleased with the result.

If we would give the grindstone any chance in a comparison of it with the emery wheel, we must see first that we get a first-class stone; one adapted in size, thickness and quality to the work it has to do. If for shop tool grinding, it should be of fine, sharp grit, and particularly it should be uniform in hardness. I do not think it desirable to have it more than 30″ to 36″ in diameter, or more than 2½″ to 3″ in thickness. Many tools can be ground best near one edge or other of the face, and if the stone is thick it will get worn down at the corners quicker than in the center. A strong, well-made wooden frame is good enough,

The axle should be secured against end play, and should be supplied with collars at least one-fourth the diameter of the stone. They should be slightly concave, and, with leather or rubber packing between them and the stone, they should be set up very tightly—so tightly that all tendency of the stone to burst would be outside of where it is gripped by the collars.

I do not think that any of your correspondents have recommended a speed for a good close-grained stone that either reaches the limit of safety or that will give the best results from an economical point of view. The coarse, open-grained stones, 56″ in diameter, used in grinding wood pulp, although subjected to a tremendous working strain, run at about 250 revolutions per minute, or at a speed of about 3,660 feet; and there is no doubt that, owing to some check in the feeding apparatus, and to bad regulation, this speed is frequently increased at least 25 per cent., and yet accidents rarely occur. And I fully believe that a stone that is adapted to tool grinding, and so thin that any defect could be easily found, can be run with entire safety at or over 4,000 feet; and I know of one quarry, a stone from which I would not fear to risk at 5,000.

Some might find difficulty in keeping water on a stone at such a speed, but I would recommend the following plan, which I have found to work well. I put a shelf over the top of the stone, and only an inch or so above it. I then folded up a piece of the coarse open wrapping cloth, such as comes around belting, rubber packing, etc., so that it was a foot or more long, about as wide as the thickness of the stone, and four or five folds in thickness. I tacked one end of this to the shelf over the stone, and allowed the rest to trail down on it. I then placed a pail or tub supplied with a drip cock on the shelf, filled it with water, and allowed it to drip on the cloth, which would distribute it well over the face of the stone, keeping it sufficiently wet, but not wet enough to throw it everywhere. Some kind of catch basin and pipe should be placed under the stone to catch any water that may drip from it.

A stone running at the speed that I have recommended will last two or three times as long as one running at the usual speed. It will have to be kept round and true on the face by means of some one of the rotary stone dressers, as it cannot be turned true in the usual way—with an iron bar.

I think it well to set a grindstone a little higher than usual, and to secure a flat iron bar, about on a level with the axle, with its edge almost touching the face of the stone on the side running down; and if tools are held down firmly on this bar they will not tend to dig into any inequality that may occur in the stone. T. H.

Arranging Grindstones.

Editor American Machinist:

I enclose you sketch and description of arranging grindstone, which I think will answer Mr. Newell Sanders' inquiry.

In running high-speed stones the following points should be well attended to: that is, the face of stone should be turned crowning for the purpose of diffusing water over its surface as it comes from the pipes arranged at the side of the stone, the centrifugal force carrying to the highest point on the same. To get the best results from a stone its face should be hacked with an axe across the face of stone; impression should be made two or three inches apart, and about ¼″ deep.

The side pipe should supply just sufficient water to keep the loose grit from washing off the face of stone, for it is the free grit that keeps the stone sharp. In regard to speed, would say that I have run stone, when the work was such that the lives of the workmen were not in danger, as high as 6,000 feet per minute; but I would not advocate that speed, for the stone frequently burst. But I do regard 4,000 feet per minute a perfectly safe speed. Stones with red seams in them should be avoided, for they show the presence of iron, which is an indication of weakness and soft spots. The binder in sketch is for the purpose of slowing the speed of stone when it is to be turned off; a ⅝ square rod will be found to be the best thing for this purpose. For machine shop use the stone should be cased in with the exception of an aperture at the top to grind through. To attempt to grind over a rest on a stone at that speed would probably result in the loss of an arm or even a life.

Chas. Pratt.

[Fig. 1 is a skeleton diagram, showing Mr. Pratt's arrangement of pulleys and tightener. The larger circle represents the grindstone, which is mounted upon timbers over a pit, and supplied with water from pipes which pass along each side of the stone parallel with its sides, and have holes drilled in them for throwing the water in small jets against the sides of the stone, instead of on its face, as is usual. Fig. 2 is the shaft and collars for a 6-foot stone. It is of steel 3″ diameter with journals 9″ long. The flanges are 12″ diameter, and there is one inch thickness of wood on each side of the stone. The loose collar has a spherical recess in it, and under the nut is a washer, one side of which fits this spherical recess and allows things to adjust themselves without any cramping.]

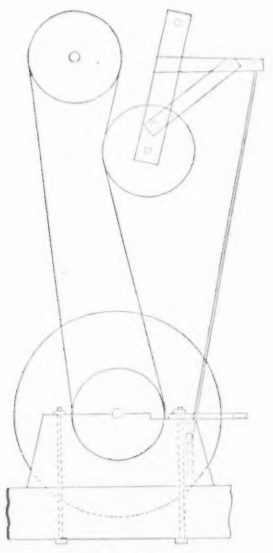


Fig. 1.

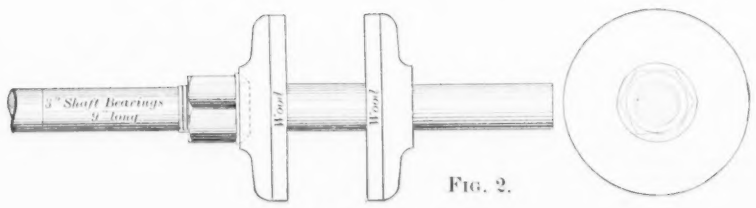


Fig. 2.

Arranging Grindstones.

Emery Wheels—Tool-Holder—Center Holes.

Editor American Machinist:

I am not an emery wheel crank, but when "A Mechanic" attacks the emery wheel in such unmeasured terms, it seems as if I must have a little to say.

We have here, running ten hours per day, several mandrels in drilling lathes, running 18,000 turns a minute. Any machinist knows that a soft mandrel would not be worth much at that speed.

In old times those mandrels were hardened, then ground in a lathe by means of a stick held in the tool post, and fed with oil and emery. Would any one question that a good universal grinder was better than the old way?

Instances might be multiplied to show that we produce work which, without emery wheels, would be impossible. Example: Hardened spindles and journals for engine lathes and milling machines.

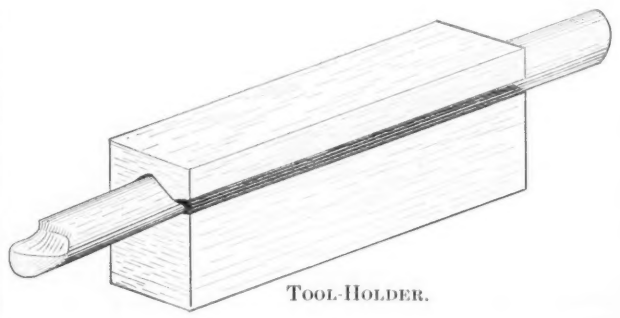
I fail to see how any one can question their superiority over soft ones.

One thing in relation to soft emery wheels. Some months ago a cutter grinder came into the shop; with it directions that as the wheels were soft it should be run at its highest possible speed to give good results.

There was no question as to their softness; they could be picked to pieces with the fingers, and as for cutting, they did none; they crumbled to pieces.

An order was put in to the same wheel company for a hard wheel; the result was that wheel cuts free and does not glaze at all. Will Mr. Norton please explain why he advocates using such soft wheels?

One use for emery wheels I have never seen mentioned, is their capacity to grind rubber. I have ground soft, pure rubber rolls 6 feet long, 8″ diameter quickly and easily by using a coarse wheel, fed with chalk to prevent the rubber melting and adhering to the particles of emery. Why don't some enterprising firm fit up some good grindstone troughs, with a hood to prevent water flying? and then some settlement of this grinding question could be brought about. We increased the speed of ours a few days since, and it cuts first-rate, yet it means a shower-bath when we put the water on.



Tool-Holder.

This sketch of a boring tool-holder will explain itself. We find it quite handy on small work, allowing as it does the making of tools from rod of any shape and length. I find by my short experience that I cannot bore and ream a center hole, and have it run true. For this reason the teeth of the reamer are never perfect straight edges, consequently the hole will be more or less ridgy, and out of truth.

I speak of this because I find in milling machines and lathes that the center holes are not concentric with the mandrels, and they are generally reamed. Why not bore (or preferably grind) the hole? and then it will be true.

When a milling cutter runs out, we are losing one of its best features, *i. e.*, its multiplicity of cutting edges, which give it the advantage over planers, because only two or three teeth strike per revolution. Very likely in lathes used for ordinary work absolute accuracy is not essential in center holes, but for tool-room lathes, where many changes are made during a job, there should be perfect truth.

Illustration: We have two 16″ lathes and one 20″ drill press whose center holes are duplicates, and hardly a day passes that we do not make use of some chucks or attachments which otherwise would require either a duplicate set of tools or changing the work from one machine to the other.

Bristol, Conn. A. W. Parkhurst.

Truing up Lathes.

Editor American Machinist:

I am a tool maker employed in a big concern in this city, and as such have considerable repairing and truing up of lathes to do. I have followed closely all the articles in your paper relating to the truing up of lathes, respecting their alignment, but was unable to use them, owing to the want of the tools required. Here is my method:

First I face the face plate straight by a good straight-edge. Then I clamp a square as large as I can use it to the face plate. To see if the spindle is in line with the shears, I turn the face plate around till the square is horizontal, clamp a suitable piece in the tool post, and run the carriage along the square, trying with pieces of tissue paper at different places. If it does not feel the same in every position, it shows me plainly which way to shift the spindle.

To see if the center line of spindle is the same height in front as in back, I place the square vertically, and run the carriage along, trying with paper again. After I have the head-stock adjusted I true up the tail-stock by taking a piece of iron between the centers, and clamping a pointer to the piece. Then I try this pointer against the face plate by revolving the piece between centers, and adjust the tail-stock till the pointer touches the same everywhere. I adjust the tail-stock first with the center as far back as it will go, then, to try if the spindle of the tail-stock moves in line with the shears, I run the spindle out as far as possible, and try the pointer again against the face plate. If it touches the face plate everywhere when revolved, I know the tail-stock spindle is in line; if not, I can plainly see which way to move it.

This method I have found to give results as accurate as possible.

It may be said this method is old, but I have never met a tool maker yet who was acquainted with this simple method, and I give my experience, therefore, for others' benefit. J. Grening.

Grindstones and Emery Wheels.

Editor American Machinist:

Having read with interest the opinions of many practical men upon the subject of emery wheels and grindstones, it has led me to give my opinion and experience. If I have a tool from which a large amount of stock is to be removed I will have it cut off by the tool forger, or annealed, and file it to the proper shape; for then I can, without any difficulty, shape it just as I want it, without getting a bath from an emery grinder, or giving some one else one. I believe that a tool will hold its edge longer by being ground upon a grindstone. I notice most good workmen who use an emery wheel finish the tool upon the stone. If we are to use emery wheels we should get wheels that are adapted to all classes of our grinding, and I think we would find that very expensive.

In the most shops where I have seen grindstones used, they have carelessly let them go until they get so bad that it is with great difficulty that they can be used. I have even seen men lose a finger in trying to use them. After an accident happens they look up the truing device, bolt it on and raise the threaded roll so that it will come in contact with the stone with such force that small pieces will chip from the stone, and also strain the device so as to render it worthless. Very often it will stick in its bearings, for want of oil.

A grindstone would give better satisfaction if kept in proper shape. If it is kept in proper shape—trued off every day—I will take it in preference to all the emery wheels in existence; for I think it the cheapest and best tool grinder ever invented.

Noname.

Letters in Cast-Iron.

Editor American Machinist:

I clip the following from the *Boston Herald:*

Mr. John Farrar, foreman of the G. W. & F. Smith Iron Company of Boston, sends to the *Herald* three small cast-iron plates, one of which is 3½ by 5 inches, on which is cut in sunken letters—etched—the Lord's Prayer in bold handwriting, and the other two, each 5 by 6 inches, containing outline drawings, one with three sketches—a pig in an enclosure, swans on water, and a deer, with pyramids in the distance, and the other plate containing an outline drawing of a horse. Referring to these plates Mr. Farrar says: "What you see on them is done with a common steel pen on a piece of thin paper. The paper when prepared is pinned into a sand mould, iron is poured into the mould, and the writing is transferred to the casting. I like to stir up these moulders. I have worked fifty-four years in a foundry, and there is a great deal for me to learn yet." Mr. Farrar's plates are

a curiosity, and may be suggestive to practical men.

I suggest that when the ink is fresh some fine sand be sprinkled over it, and the paper put into the mould with the writing down, and that the hot iron burns away the paper, leaving the sand in position. Next!

P. H. B.

Nitrate of Tin.

Editor American Machinist:

In the AMERICAN MACHINIST for March 13, under Questions and Answers, there was one statement made which I wish to correct. The question was No. 96: Where can I obtain nitrate of tin? Answer: "From any wholesale druggist. Nitrate of tin is obtained by adding potassa, or an alkaline carbonate, to a solution of perchloride of tin. This substance is also known as stannic acid."

Your correspondent must have got mixed up, as his statement is entirely wrong. There are two nitrates of tin. It is doubtful whether your correspondent, unless he was a very experienced chemist, could prepare either of them. One nitrate of tin is not known in a solid state; it can only be prepared in a solution, and with great difficulty. The only process which would be at all successful, and would stand a chance of getting a product, would be to dissolve pure tin in a mixture of strong nitric and muriatic acids, cool the solution, and add considerable ammonia. The substance that separates out should be filtered off, and dissolved in very strong nitric acid. The process will probably not be successful; but, if it does succeed, scales of nitrate of tin will separate out. Even then the substance will not be permanent, but will change on exposure to the air to tannic acid.

If your correspondent can find anything else that would suit his purpose just as well, he had better not bother with this, as it is a great deal of trouble.

I think it is very doubtful whether it can be obtained at drug stores.

J. TORREY.

Belt Driving.

Editor American Machinist:

In your issue of March 13 I see an illustration of a device to take the place of quarter turn belts, and I am surprised to learn of its being considered as little known. I have used this device many times, and every time with good success. For instance, I put one into a paper mill in place of pair of bevel gears, I think in 1877, in this instance running a 14″ double belt; also in 1888 one in place of a mule stand in J. B. Coleman's machine shop, Elmira, N. Y. This was an 8″ belt over 20″ pulleys, with shafts about 3 feet apart. The mule stand which this replaced was a continual nuisance. This device was put in, and has never caused one minute's trouble; in fact, it ran for eighteen months, ten hours per day, before the belt had to be taken up. I do not know who invented it. The first one I ever saw was in Holyoke, Mass., over twenty years ago, in place of quarter-turn or mule stand, and when it can be used in place of bevel gears it is without doubt a success.

In regard to belts, my experience with leather belts is that, run with the hair side next the pulley, the life of the belt is 25 per cent. longer than with flesh side, allowing the same care in running, and the same work. When run hair side out and worked hard, the outside of the belt cracks, the cracks fill with dust and grit, and the result is the belt is soon worn out.

One thing which spoils many leather belts is a habit indulged in by some who claim to be mechanics, of, when a belt slips, putting on powdered resin, or running for a cake of soap and holding that on the belt —either one spoils the belt. When a belt slips take it up; then if it slips put on a wider belt, and in the end it is money in your pocket.

F. P. WOLCOTT.

The record for fast time between New York and Washington has again been broken by the Pennsylvania Company, which ran a special train from Jersey City to Washington, March 10, in four hours seventeen minutes, including stops. The previous best run was made by the train which carried New York surgeons to Washington when President Garfield was shot, the time then being five hours thirteen minutes. No unprecedentedly high speeds seem to have been reached, but it was a case of keeping steadily at it. The best run, from Jersey City to West Philadelphia, where engines were changed, was made in ninety-four minutes, the distance being ninety miles. The train was delayed about three minutes during this run, however, by the conductor, who imagined something was wrong because the gravel of the road-bed was flying about the cars.

Amateur Engineering.

Not long since Dr. R. H. Thurston, in an article published in our columns, called attention to the remarkable readiness displayed by the free-born American citizen to undertake at short notice any kind of engineering work for which he had had no training or experience whatever, and the no less remarkable amount of attention which such an enterprising aspirant for engineering honors was able to command from the public, and often from those having it in their power to decide who should be entrusted with the work.

Dr. Thurston's remarks were called out by the proposal of a lawyer to design an iron-clad, and the seemingly serious attention secured for his proposal. We heard recently of a similar instance, in which things have gone much further than a mere proposition, and in which the results seem likely to be much more serious.

The town of Westfield, N. Y., concluded to put in water-works, and a resident of the town, a banker, was placed at the head of the commission which was charged with carrying on the work. Instead of employing an engineer, this banker convinced his colleagues that he himself was fully competent to do the work. He undertook it, and they decided upon a gravity system. The banker —civil-and-hydraulic-engineer—got some instruments and went to work. The blunders he made were, of course, numerous and ludicrous, the end of the matter being that the firm of contractors who undertook the work were involved in serious difficulty, and the town seems likely to have a lot of bonds outstanding, with little or nothing of value in return for them.

Of course there is an abundance of instances in which men who ought to know better have undertaken to design expensive machines or arrange manufacturing plants without having had the least experience which could by any possibility give them any right to expect success.

An instance is recalled in which a manufacturer of saws, who had thoroughly learned that trade, and had made money at it, wanted a new shop. He arranged it himself, and, along with the other features, had his grinding-room in a dark and low-ceilinged basement, the engine being just outside, so that the main driving belt from it to the line shaft was horizontal, and crossed the grinding room at a distance of about six inches from the dirt floor. It was about the middle of the room, with grinding machinery each side of it, so that workmen in passing had to duck their heads to avoid striking the upper side of it with their heads while they stepped over the lower side. The floor gradually filled up by the accumulated dirt, until a trench had to be dug under the lower side of the belt, and this trench often had water in it coming from the grindstones. Then the belt would refuse to do its work, and it cost so much for new belts that it was finally decided to rearrange things, which was done by substituting cog-wheels for the belt. These were rough, and bored out so badly that the high side of one had to be arranged to engage with the low side of the other to make them turn over; and when they finally did turn over it was discovered that the shaft went in the wrong direction. This was fixed after much trouble, but the noise and violent fluctuations of speed, due to the eccentricity of the gears, remained. There was, however, no serious objection to the arrangement on the part of the saw-maker until the first month's coal bill came in, when there was other music besides that furnished by the gears.

There is no department of engineering which the layman hesitates to enter, and he apparently thinks that all an able man like himself needs to do to show the professional how things should be done, is to simply apply his mind to it. Training and experience count for nothing with him. Where the expense of these engineering enterprises is borne by the doughty engineer, as was the case with the saw-maker, no one seriously objects; but when others suffer, as in the case of the town of Westfield, there is apt to be some complaining by the victims. In either case somebody learns a lesson, however, and we suppose that, when enough of these lessons have been learned, the accumulated wisdom resulting from them will force the amateur engineer to take a somewhat less prominent part in the progress of the world.

Our Five Cent Nickel and the Metric System.

BY COLEMAN SELLERS.

Noting your extract from a Western paper on this subject in a recent issue, I beg leave to call your attention to an article in the Boston *Journal of Commerce*, Saturday, Feb. 26th, 1881. Practically the same note, then going the rounds of the papers, was sent to me, and the editor of the journal, from data I obtained from the U. S. mint in Philadelphia, showed how little truth there was in the supposed connection between the nickel and the metric system. The conclusion of the article of 1881 was "In regard to this metric (?) five cent nickel, all we can say of it is that if they are turned out of the mint, of the size and weight they are designed to be, then three of them will weigh the postal half ounce, five of them placed in a row will measure four inches, and forty-five of them placed in a row make one yard." So much for the coin that contains "the entire metric system of weights and measures." Feb. 18th, 1881—a letter from the officer of the United States mint, who has charge of the dies, says of the five cent nickel, its diameter should be $\frac{16}{20}$ of an inch, its thickness .062 of an inch, and its weight 77.16 grains. The legal allowance from the above weight being "three grains." That is, they may vary 3 grains one way or the other from 77.16 grains.

Curious to learn how the coins of later date compare, I selected from well-conditioned pieces on hand, a number of the dates given below, and procured from the mint direct 20 new coins, fresh from the press, dated 1890. These I weighed with exceeding care, piece by piece for a number, and in the case of the new ones, in tens, with the following results. The diametrical measures taken with a carefully adjusted micrometer gauge:

1	1868	diam.	.8078	in., weight	4.750	grammes
1	1869	"	.8074	" "	4.820	"
1	1883	"	.8083	" "	4.940	"

The above with the old design of face:

1	1883	diam.	.839	in., weight	5.020	grammes
1	1883	"	.8365	" "	4.970	"
1	1884	"	.83625	" "	4.88	"
1	1887	"	.839	" "	4.960	"
1	1887	"	.837	" "	4.940	"
1	1889	"	.837	" "	5.000*	"

For 1890 the average size is .8385 inch.
10 weighed, averaged in weight 4.972 each.
10 " " " 4.940 each.

The above 20, all 1890, and of these I found none weighing 5 grammes, 7 were over weight, and 13 light weight.

No coin can be relied upon as being standard diameter. The diameter is fixed by the "collar," which is taper, and, being submitted to great strain, is apt to vary; besides, there is no reason why they should be kept to exact size, nor have any of the mints any instruments for exact measurements; by exactness I mean what is now common in the best regulated machine shops. I have had occasion to measure very many coins of gold and silver, and would have been surprised at the variation, had I not known the conditions that obtain in the use and manufacture of the collar, as distinct from the dies that make the face and reverse of each coin.

* This is the only coin weighing 5 grammes.

All the base metal coins used in the United States are and have been struck in the Philadelphia mint, and the workman who makes the collars tells me that no metal is so hard on the collar as the alloy of nickel. The metal used varying very much in its hardness.

While looking up my notes on this subject, as prepared ten years ago, I came across the information in regard to the use of the metrical system in the post-office. It seems by virtue of Regulation of Detail XXVI., and Section 1108 postal laws and regulations, 15 grammes equal 231.48 grains about, is equivalent for *postal purposes* in the United States, to $\frac{1}{2}$ oz. avoirdupois, or to 218.75 grains, or 12.73 lighter than 15 grammes. I made up a package in letter form that would just not turn the scale of 15 grammes, and presented it at the post-office to know its postage for France. At each window I was told that it would go for five cents, or one postage, this even after I had said it was over weight avoirdupois, and had been carefully weighed on several scales. From this I infer the postal scales are graduated to the 15 grammes equal $\frac{1}{2}$ oz., weighed on any druggists' or grocers' scale the package would be over weight so decidedly as to bear no contradiction, while on the postal scale on my desk this package close to 15 grammes is clearly over $\frac{1}{2}$ oz. The moral is, do not weigh letters for foreign postage on any but postal scales; and do not use postal scales in weighing drugs, or where accuracy is important.

The great beauty of the metric system lies in its harmony of weights and measures. The great fault is in its unfitness for many purposes, and its being so badly adapted to binary division. A cubic meter of distilled water weighs one tonne. A cubic decimeter weighs one kilogramme, or about 2.2 pounds avoirdupois.

A cubic centimeter of distilled water weighs one gramme.

The instruments used to fix these weights were not vessels of cubical form, that could be measured with readiness They are cylindrical vessels with all that accompanies the determination of the value of the circle as compared to the equivalent square.

One yard of one inch square iron weighs 10 pounds so nearly as to give us the handy rule for determining the sectional area of shapes; their weight per yard, divided by ten, equal square inch area of section.

I think it more than likely, should one need to originate the pound avoirdupois, that a bar of ordinary iron planed to a square of 1″ on a scale, and made 36″ long, will be found to weigh more nearly ten pounds than any equally crude attempt to re-establish the kilogramme for a cubic decimeter of distilled water.

I speak feelingly and knowingly in regard to this last matter, having had to do with the making of the bronze vessels used in the coast survey department to make the standard vessels of measurements on the metrical system for the Government. The metrical system can be used to great advantage in many industries and for many purposes. As a chemist, I should surely use it in preference to any other system; in the machine shop by no means. This, after more than forty years familiarity with it in almost daily use.

To go back to coins. It may not be commonly known that coins are all made to multiples of $\frac{1}{20}$ of an inch; from the double eagle of $\frac{87}{20}$ .077″ thick, 516 grains weight, with a legal allowance, light or heavy, of $\frac{1}{2}$ grain, down to the gold dollar of $\frac{15}{20}$ .018″ thick, 25.8 grains, and a legal allowance, light or heavy, of $\frac{1}{4}$ grain. All silver coins may vary $1\frac{1}{2}$ grains either way, while the bronze cent, $\frac{16}{20}$ diam. .043 thick, 48 grains weight, can vary two grains either way.

The silver dollar, $\frac{80}{20}$ diam., is the nearest in supposed diameter to an even $1\frac{1}{2}$ inch; the cent is about $\frac{3}{4}'' = \frac{15}{20}''$.

No United States coin can serve as a measure of accuracy, either in weight or in dimensions. The three dollar gold piece should be $\frac{3}{5}$ of one inch. The silver half-dollar, $\frac{78}{20}$ inch diam., is nearer to 30 millimeters by measure than the nickel to the two centimeters.

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The Eight Hour Movement.

The movement for an eight hour day is just now attracting considerable attention, and probably has more force behind it than some are willing to admit, though it is equally true that its force is over-estimated by others.

Many of the arguments urged against it were urged against the adoption of a ten hour day, when it was the custom for men to labor from twelve to fourteen hours, and are just as reasonable now as then. The most silly and brutal of these is that more leisure for workingmen will mean more time for dissipation and more mischief.

The arguments most often put forth on the workmen's side are that improvements in labor-saving machinery and in processes of manufacture have increased the production of workmen from two to a hundred-fold since the adoption of the ten hour day, and that much, if not most of this increased productive power is due to improvements introduced by workmen almost as a direct result of their having more leisure for the study of matters pertaining to their business, and that therefore the time seems to have arrived when some of the increased leisure, made possible by the introduction of machinery, should be enjoyed by the workmen themselves. It is also pointed out that there are about a million unemployed men in the country, a large proportion of whom would find employment if the length of the working day were reduced, on account of the additional men required to do the same work. Another argument frequently put forth, especially when the question of wages is considered in this connection, is, that ten hours continuous daily labor is too much, considered from a physiological standpoint, and that a reduction of the hours of labor would, by improving the physical condition of workmen, cause nearly, if not quite as much work to be done as now.

The inconsistency of the last two arguments need scarcely be pointed out; for it is very plain that, if as much work will be done in eight hours as is now done in ten, there will be no demand for more workmen, caused by a reduction of hours. The truth of the matter is that in some lines of work, as much would be done in eight as are now done in ten, while in other lines the reduction of the amount of work done would be exactly proportionate to the reduction of time. In the latter class belong all those occupations which consist simply in feeding or otherwise attending to machines which are run at a uniform speed by power, and which turn out a given quantity of work per hour, so long as they are kept in motion, and which involve no exhausting physical labor in attendance. Where the production would not probably be much, if at all reduced, is in the case of work which is done mostly by hand, and is of such a nature as to be tiresome or exhausting, and where the production per hour depends almost entirely upon the physical condition of the workman.

In the first case mentioned—that of production chiefly by machinery—there would be an increased cost of production, caused by a reduction of hours of labor, even if wages per day were correspondingly reduced; for most of what are known as the fixed charges would remain the same. Assuming the investment of a manufacturer in his plant to be $1,000 per man employed, the interest on this would be the same, regardless of the number of hours worked, as would also be the insurance, superintendence, cost of maintenance, etc.

This would of course cause an increase of the total cost of production, even though the wages cost per piece of work turned out be kept the same by a reduction of rates per day.

If there could be a general agreement among all, or nearly all workmen to demand, and all or nearly all employers to grant a reduction of hours, it would be a simple matter. Prices of manufactured goods would simply advance in proportion, to the increased cost of production whatever that might prove to be. But such an agreement does not seem probable at this time, and the problem is therefore a complicated one. Most manufactured goods must sell, if at all, in competition with similar goods from other factories. In New York and Philadelphia, machine tools made in these cities meet and come into direct competition with those made in Ohio and New England. The same is true of other machinery. No one location has such an advantage over the other that any considerable increase in cost of production can take place, without destroying the industry there, unless there is a corresponding increase in the other localities, and the same is true of most other manufactured goods.

And this is just where the essential difference comes in between such industries as these and the building trades in which some of the workmen here in New York at least have already secured the reduction of hours without reduction of wages. Buildings are not constructed in one place and then loaded onto freight cars to be taken and sold somewhere else. They are paid for and used where they are constructed, and may therefore, for a time at least, be much more expensive in one place than in another, and still continue to be erected there, and in fact this may continue to be the case permanently where one location has decided advantages over another as a place for business, all of which is not absorbed by the mere owner of the land. But where such unappropriated advantages do not exist, the increased cost of buildings in the one place over that of the other, will in the end show itself in the increased cost of doing business there, giving other places an advantage, and causing most or all the building to be done in those places.

It must be apparent to any one who seriously studies the matter with a desire to be fair to all parties in interest, that it is a somewhat complicated question.

No one, we think, who is at all familiar with the course of this journal will doubt our sincerity or desire to be entirely fair in the matter, when we say that we think it would simplify matters very much if present efforts were confined to an effort simply to lessen the hours of labor, where such reduction seems possible, leaving the matter of wages to be adjusted afterwards in accordance with business law, which is the only basis upon which they can be permanently fixed. In any event, we hope to see forbearance and a disposition to be reasonable and fair on both sides.

Few employers will, we think, be found to deny that, in the main, increased leisure for those who toil at the work benches and in attendance upon machinery is desirable, and would in the end result in better and more intelligent workmen. But at the same time it should be fully recognized that in any such movement there are obstacles to be overcome, which are not founded in mere stubborn selfishness. And above all things we recommend that workmen and employers get together quietly, and calmly discuss the matter, and then see what can and what cannot be done. This will be found a much better way for both than to simply assemble in separate and hostile camps to demand things, and to denounce and abuse each other.

The Lake Shore Wreck.

Apparently the sole result, so far, of the investigation into the cause of the Lake Shore accident has been the holding of conductor Houghtaling in $500 bond, charged with a misdemeanor. In his testimony before the coroner's jury, conductor Houghtaling made statements which show plainly that he could easily have prevented the accident, and would have done so had he taken the precautions or exercised the care and judgment that would naturally be expected of an experienced railroad man under such circumstances. He fully understood the condition of the train, and must have also fully understood the risk involved in running it in that condition. There can be no doubt that he also knew what measures could have been taken to make it safe. Now if he alone was to blame for the dangerous condition of the train, and for the failure to take the necessary precautions to insure safety, it certainly seems as though he is guilty of much more than a simple misdemeanor. But if he was not solely to blame, but had had it impressed upon him that it was necessary for him, above all other considerations, to make the time, even if trains had to be run in a dangerous condition, then some one else should be prosecuted with him.

To make out that such a flagrant piece of carelessness, resulting in the death of seven people, is nothing more than a misdemeanor upon the part of the man held solely responsible for it, is simply a travesty upon justice, and an invitation to similar carelessness upon the part of others.

Elsewhere in this issue we publish an article on Captain Ericsson, written by Professor MacCord, of Stevens Institute. Professor MacCord was one of Ericsson's aids for about nine years, and the thorough knowledge he gained of the man and engineer in that time gives the force of truth to what he writes. The article is both interesting and instructive.

Last December our always enterprising contemporary, *The Engineering and Building Record*, offered cash prizes amounting to $250, for competitive designs of water-works, pumping stations and water towers. The time limit has expired, and our contemporary has in hand 112 designs, which are said by those competent to judge to possess merit in a high degree. The awarding committee were: Edmund M. Wheelwright, of Boston; John W. Root, of Chicago; Amos J. Boyden, of Philadelphia; F. A. Wright, of New York, all well-known architects, and Dexter Brackett, engineer of the Boston water-works. The first prize was given to Elmer Grey, of Milwaukee, the second to James C. Green, of Brooklyn, the third to R. C. Spencer, Jr., of Boston, and the fourth to J. A. Schweinfurth, of Boston.

It is urged that, in view of the possibilities of architectural skill in designing such structures as demonstrated by this competition, there is no excuse for disfiguring the landscape by putting the usual unsightly iron cylinders on the most commanding position in each town. The designs will be on public exhibition in New York.

QUESTIONS AND ANSWERS.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly and according to common-sense methods.

Every question, to insure any attention, must invariably be accompanied by the writer's name and address. If so requested, neither name, correct initials nor location will be published.

(117) C. J. D., Mt. Vernon, O., writes: Please give me information in regard to making prints by the black process. *A.*—The process for obtaining dark blue lines on white ground has been described in our issue of January 22, 1887. Nearly all the other processes which are of practical value for obtaining dark or black lines on white ground are patented, and the information relating to these prints you will have to obtain from the patentee.

(118) W. H. P., North Amhurst, O., writes: Suppose an engine cylinder is built to take steam in the middle between two pistons to travel in opposite directions; would there be any more power from the two than there is from one taking steam at end at the same steam pressure? If not, what becomes of the pressure against the cylinder heads in a cylinder with a single piston? Is there not as much steam pressure against the head as there is against the piston? What is the theory of it? *A.*—There is just as much pressure on each of the two pistons as there is on the heads of a cylinder in which only one piston works. But it must be remembered that the power is not measured by the steam pressure only, but it is measured by the product of the pressure into the distance through which the pressure acts. If, for instance, we have a cylinder with two pistons, the steam being admitted between the pistons, and the cylinder is long enough to allow each piston to travel two feet, and the total steam pressure on each piston is 1,000 pounds, then each piston will perform $1,000 \times 2 = 2,000$ foot-pounds; that is to say, each piston will have the power of raising 2,000 pounds one

foot high, or both pistons are capable of raising 4,000 pounds one foot high. If we now use only one piston, whose thickness is equal to that of the two pistons in the same cylinder, the single piston can then travel through 4 feet, and, since the steam pressure remains the same as before, the single piston is capable of performing $1,000 \times 4 = 4,000$ foot-pounds of work, which is equal to that of the two pistons combined. Hence, as far as work is concerned, nothing is gained by using two pistons instead of one. The idea is an old one; it has been tried, and, as far as power is concerned, nothing has been gained by it.

(119) H. W., Baltimore, Md., writes: We have lately patented a machine to wash type forms, which we are now perfecting. One of the parts is a cast-iron box to hold about five gallons of concentrated lye, which is taken out through a half-inch brass spigot when wanted. We find the spigot corrodes in a very short time, and is rendered thereby utterly useless. Can you suggest a remedy for this, or advise us in any way if anything can be done to overcome this difficulty? *A.*—From your letter we conclude that the lye does not affect the cast-iron; we therefore suggest making the spigot also of cast-iron. If this does not answer the purpose we suggest giving the whole matter into the hands of a reliable chemist. His analysis may point to a remedy.

(120) C. W., New York, writes: In your answer to Question 54, you say, "Place the smooth side next the pulley," but I have heard what, in my humble judgment, I consider a good argument against it. The vitality of the leather is in the hair (or smooth) side; therefore, if it is placed against the pulley and worn off, the vitality is lost, and your belt is useless. On the other hand, if placed the rough side to the pulley, you can wear your belt pretty thin and still keep its main strength. Question 1. Why put the smooth side next the pulley? *A.*—Partly for the reason that the belt adheres somewhat better, and partly for the reason that the best part of the leather is on the opposite side to that which you suppose, and the wearing away of the smooth side impairs the strength of the belt least. Your questions regarding the flow of water through hose under a vacuum cannot be answered without knowing the length of hose and all other conditions.

(121) E. S., ———, asks: 1. How can the mean effective pressure on a square inch of piston be ascertained? *A.*—By the use of an indicator; or it can be computed by means of a table published in our issue of September 5, 1889, or by the rules given in our last issue. 2. Does it hurt machinery to be in a cold room which is quickly heated? I have noticed in cold weather a sort of sweat come out on my machinery when the shop is warmed. *A.*—The warming of the shop does not cause this, but it happens that at the same time the shop is warmed, moisture is in some way introduced into the air of the room, which is condensed on the surface of the machinery, and is what you call sweat. This moisture may be caused by leakage of steam, or possibly comes from the breath of persons who come in at that time. It may rust the machinery, and in that way do some harm. If there is a leakage of steam, stop it; but if it comes from the breath of the people who come in while the machinery is cold, commence heating the shop earlier in the morning.

(122) G. J. T., Liverpool, Pa., writes: We wish to purchase an engine for our shop. The most power we will require at any time is six horse, and usually not over two. We can buy a plain slide valve engine very cheap. Size, 8″x16″; steam ports, $\frac{5}{16}$″x5¼″; exhaust port, 2″x5¼″. What number of revolutions should the engine be run at? *A.*—The proper speed of this engine is about 160 revolutions per minute; but for six horse-power, and with a boiler pressure of 60 pounds, it should not be run over 50 or 60 revolutions per minute. 2. What would be the horse-power of this engine with 60 pounds boiler pressure? *A.*—When the engine is running at 160 revolutions, about 19 indicated horse-power will be developed. 3. Will the above engine be as economical in the use of fuel for the power required as a smaller one, or will it pay us better to purchase a smaller one? *A.*—It will pay you to buy a smaller engine, say a 5″x7″, running at about 350 revolutions per minute. The large engine will not be as economical in the use of fuel as the smaller one. 4. What is the smallest upright tubular boiler you would advise us to use for the engine? *A.*—Diameter of shell, 36 inches; height, 78 inches; diameter of fire-box, 31 inches; height, 42 inches; 55 two-inch flues.

(123) C. P. S. and W. F., Chester, Pa., ask for a rule for figuring gears to cut threads. This is an ever-recurring question, and we reprint from the last volume rules intended to cover any case. If the lathe is simple geared, and the stud runs at the same speed as the spindle, then select some gear for the screw, and multiply its number of teeth by the number of threads per inch in the lead screw, and divide this result by the number of threads per inch which you wish to cut. This will give you the number of teeth in the gear for the stud. If this result is a fractional number, or a number which is not among the gears which you possess, then try some other gear for the screw. But if you prefer to select the gear for the stud first, then mulitply its number of teeth by the number of threads per inch which you wish to cut, and divide by the number of threads per inch on the lead screw. This will give you the number of teeth for the gear on the screw. If the lathe is compound, select at random all the driving gears, multiply the numbers of their teeth together, and this product by the number of threads you wish to cut. Then select at random all the driven gears except one; multiply the numbers of their teeth together, and this product by the number of threads per inch in the lead screw. Now divide the first result by the second, and you will have the number of teeth in the remaining driven gear. But if you prefer, you can select at random all the driven gears. Multiply the numbers of their teeth together, and this product by the number of threads per inch in the lead screw. Then select at random all the driving gears except one. Multiply the numbers of their teeth together, and this result by the number of threads per inch of the screw you wish to cut. Divide the first result by the last, and you will have the number of teeth in the remaining driver. When the gears on the compounding stud are fast together, and cannot be changed, then the driven one has usually twice as many teeth as the other, or driver, in which case you can, in the calculations, consider the lead screw to have twice as many threads per inch as it actually has, and then ignore the compounding entirely. Some lathes are so constructed that the stud on which the first driver is placed revolves only half as fast as the spindle. You can ignore this in the calculations by doubling the number of threads of the lead screw. If both the last conditions are present, you can ignore them in the calculations by multiplying the number of threads per inch in the lead screw by four. If the thread to be cut is a fractional one, or if the pitch of the lead screw is fractional, or if both are fractional, then reduce the fractions to a common denominator, and use the numerators of these fractions as if they equaled the pitch of the screw to be cut, and of the lead screw respectively. Then use that part of the rule given above which applies to the lathe in question. For instance, suppose it is desired to cut a thread of $\frac{25}{32}$ inch pitch, and the lead screw has 4 threads per inch. Then the pitch of the lead screw will be ¼ inch, which is equal to $\frac{8}{32}$ inch. We now have two fractions, $\frac{25}{32}$ and $\frac{8}{32}$, and the two screws will be in the proportion of 25 to 8, and the gears can be figured by the above rule, assuming the number of threads to be cut to be 8 per inch, and those on the lead screw to be 25 per inch. But this latter number may be further modified by conditions named above, such as a reduced speed of the stud, or fixed compound gears. In the instance given, if the lead screw had been 2½ threads per inch, then its pitch being $\frac{4}{10}$ inch, we have the fractions $\frac{4}{10}$ and $\frac{25}{32}$, which, reduced to a common denominator, are $\frac{64}{160}$ and $\frac{125}{160}$, and the gears will be the same as if the lead screw had 125 threads per inch, and the screw to be cut 64 threads per inch.

(124) C. A. W., Brooklyn, N. Y., writes: Please give formula for finding the size of feed pipe connected to a pump. For example: A boiler is rated at 250 horse-power, steam pressure 85 pounds; what should be the size of feed pipe? *A.*—A. E. Seaton, in his Manual of Marine Engineering, says: "Feed pipes leading to and from the feed pumps should be such that the velocity of flow does not exceed 500 feet per minute, and small pumps should have larger pipes in proportion, so that the flow through them does not exceed 400 feet. Since the amount of water actually flowing through the pipes is generally very considerably less than the pumps are capable of discharging, the velocity is seldom more than one-half the above allowance; but, as the pumps do occasionally deliver their full amount, the pipes must be large enough for that purpose. If d is the diameter of the feed pump plunger, s its mean velocity in feet per minute, then the diameter of feed pipe $= \frac{d}{30}\sqrt{s}$ for small pumps, and diameter of feed pipe $= \frac{d}{23}\sqrt{s}$ for large pumps. *Example*—To find the diameter of the feed pipes for a pump whose diameter is 6 inches and the length of stroke 2 feet, worked from the lever of an engine making 60 revolutions per minute. Here $s = 2 \times 60 \times 2 = 240$ feet. Diameter of pipe $= \frac{6}{23}\sqrt{240} = 4$ inches. If there are two pumps which deliver alternately, the pipes will be the same size throughout; but if the two pumps may deliver at the same time, the pipe beyond the junction of the two from the pumps must be nearly double the sectional area of one. As the resistance of pipes is due greatly to friction at the surface, and will consequently vary as the diameter, while the area of the section varies as the square of the diameter, the resistance in the single pipe will be considerably less than the combined resistance in the two, and for this reason its area may be less. In practice this area may be 0.8 of the combined area of the two. Hence, when there are two pumps delivering together, diameter of main pipe $= 1.265 \times$ diameter of branches. If there were two pumps, as in the last example, delivering together, the diameter of the main pipe would be $4 \times 1.265 = 5.06$ inches." The rating of so many horse-power of a boiler does not give us the required data for determining the size of pump and feed pipes, because some boiler makers allow 10 square feet of heating surface per horse-power, some 12, and others 15 square feet. We must know the number of pounds of steam used, or the number of pounds of water the boiler is capable of evaporating in a given time, and from this data determine the size of pump required, and then find the size of feed pipes by the foregoing rules. 2. Please state what is gained by the reduction of the discharge pipe. *A.*—Sometimes the velocity of the water in the suction pipes is slower than that in the discharge pipes, therefore the discharge pipes in such cases are made smaller than the suction pipes.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Thursday for the ensuing week's issue.

Link-Belting and Sprocket Wheels.
Send for Catalogue of Link-Belting.
Over 50,000,000 feet of Link-Belt in use.
Link-Belt Engineering Co., Philadelphia and N.Y.

Shafting Straighteners. J. H. Wells, Tampa, Fla.

"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.

The best Upright Hammers run by belt are made by Jenkins & Lingle, Bellefonte, Pa.

R. Dudgeon, 24 Columbia st., New York. Improved Hydraulic Jacks and Roller Tube Expanders.

"The Bulldozer," a new departure; forging by pressure. M'f'd by Williams, White & Co., Moline, Ill.

Pattern and Brand Letters. Vanderburgh, Wells & Co., cor. Fulton and Dutch sts., New York.

Davis Key-Seating machines kept in stock by Manning, Maxwell & Moore, 111 Liberty st., N. Y.

Selden Packing for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N.Y.

Ice and Refrigerating Machines, 140 sold, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.

Castings for small and medium-sized vertical engines. Humphrey's Foundry, Bellefontaine, Ohio.

Adjustable Shrinkage Gauges. Pedrick & Ayer, Philadelphia, Pa.

Link Milling and Slotting Machine. Pedrick & Ayer, Philadelphia, Pa.

Light Special Machinery and Tools to order. The Meriden Machine Tool Co., Meriden, Conn.

Whiton's Chucks. S. A. Smith, 23 S. Canal st., Chicago, Western Representative.

Curtis Pressure Regulators. Curtis Return Trap. Curtis Damper Regulator. See March 20, p. 12. Send for circular No. 17. Curtis Reg. Co., Boston, Mass.

Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.

For best Return Steam Traps, Pressure Regulators Positive-Acting Pump Govs., Back Pressure Valves. T. Kieley, 11 W. 13th st., N.Y. Send for des'n.

For the latest Improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.

S. W. Card & Co., Mansfield, Mass., make everything in the line of Taps and Dies. S. A. Smith, 23 S. Canal st., Chicago, Western Agent.

Patent Attorney. R. G. DuBois, 715 11th st., Washington, D. C., procures first-class patents on inventions. Valuable Hand-book on patents free.

The Sure Grip Steel Tackle Blocks must fill the bill, according to the large sales reported. See advertisement, page 13.

Watch this column for our Weekly Announcement of Bargains. Selling Overstock. McFadden Co., 1,025 Market st., Philadelphia, Pa.

25″ Upright Drills a specialty. Finely made,
28″ great capacity, quickly operated, prices low.
32″ Send for list of firms using our Drills. J. E.
36″ Snyder, Worcester, Mass.

25″ } "Only Drill Press built on
32″ } 'Ko-rekt' principles,
37″ } even if they come from Jersey."
42″ } Gould & Eberhardt, New Ark, N. J.

Patents.—Patent soliciting of high class.
D. Walter Brown, 31 Nassau st., New York.

Send for "A Brief History of Patent Legislation in the United States."

Every draftsman needs one. The Engineer's Sketch Book of mechanical movements, appliances, devices, contrivances, etc., by T. W. Barber. 1,936 illustrations. 8vo. cloth, $3. Catalogue of books on mech. subjects free. E. & F. N. Spon, 12 Cortlandt st., New York.

The Lexington Gear Works, of Lexington, Mass., have issued a Catalogue of some six hundred sizes of Cut Iron Spur and Bevel Gear Wheels. Every machine or manufacturing concern in the country should send for a copy.

De Lamater Screw Propeller Wheel made only by The Samuel L. Moore & Sons Co., Elizabethport, N. J., who have purchased from C. H. De Lamater & Co., New York, all their patterns, books of record, gauges, etc. Location and equipment well adapted for Heavy Steamship Repairs.

Stub Ends and Connecting
Rods for small connections.
Especially adapted for Valve
Rod for Steam Engines.
T. C. Dill Machine Co.,
Philadelphia, Pa.

T. R. Almond wishes to form a company for the manufacture of his patent angular coupling, or to make arrangements, either by sale of patents outright or otherwise, whereby this valuable invention may be properly placed upon the market. Address T. R. Almond, 83 and 85 Washington st., Brooklyn, N. Y.

The Prize Designs for Pumping Stations are suggestive to those about to build a Boiler House or Electric Light Station. Six months' subscription ($2) to *The Engineering and Building Record* will secure the 17 selected designs, also the Prize Essays on Road Making and Maintenance. 277 Pearl st., New York.

H. B. Roelker, 22 Cortlandt st., New York, late Sup't De Lamater Iron Works, will hereafter manufacture the De Lamater Screw Propeller.
Propellers of same pattern and workmanship as formerly made by the De Lamater Iron Works. Each designed for its special work at lowest prices.
Consulting Expert and Constructing Engineer.
Estimates made on machinery and on damages.

Just concluded. "Practical Drawing." By J. G. A. Meyer. Copies of the American Machinist containing the above series of 93 articles sent by mail to any address in the U. S., Canada or Mexico, for $4.65, or single copies 5 cents each. American Machinist Publishing Co., 96 Fulton st., New York.

"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator and making all required calculations from the diagram; also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 53 East 10th st., New York.

"Binders" for the American Machinist. Two styles, the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers with full page opening flat. Either will hold the entire 52 issues of any volume. American Machinist Publishing Co., 96 Fulton st., New York.

Just concluded. "Modern Locomotive Construction." By J. G. A. Meyer. The above series of 106 articles, which have attracted so much attention everywhere, is now concluded in newspaper form. Copies of the American Machinist containing the entire set sent by mail to any address in the U. S., Canada or Mexico for $5.30, or single copies 5 cents each. American Machinist Publishing Co., 96 Fulton st., New York.

MANUFACTURES.

The City of Keene, N. H., will exempt from taxation for ten years new manufactories.

The Anchor Foundry and Machine Works, Pittsburgh, Pa., are being extensively enlarged.

Extensive additions are to be made to the Burlington & Missouri Railroad shops at Waterloo, Ia.

Capital to the extent of $25,000 has been subscribed to establish file works at Roanoke, Va.

The Duluth Belt Line Railway Company has been organized, with headquarters at Duluth, Minn.

The town of Brattleboro, Vt., is exempting from taxation manufacturers just starting in business.

Northern capitalists are negotiating for the purchase of the Melrose Cotton Mill, Russelville, Ark.

Fay & Scott, machinists and founders, Dexter, Me., contemplate an addition to their works this spring.

A charter has been issued to the Samuel J. Creswell Iron Works, of Philadelphia, Pa. Capital, $100,000.

The Maddox Wire Belting Co. has leased a building in Saccarappa, Me., in which it expects to push its business.

The Pittsburgh (Pa.) Bridge Co. has secured the contract for building the iron bridge at Halletts-ville, Texas.

The Pittsburgh (Pa.) Locomotive Works are building a boiler shop, 120x275 feet; also a fire-proof building for offices.

The American Watch Tool Company, Waltham, Mass., are shipping the tools to equip a watch factory at Prescott, England.

The Prospect Rolling Mill., Cleveland, Ohio, has been closed, and the workmen paid off. Lack of funds to carry on the business on the scale projected is said to be the cause of failure.

The Pittsburgh (Pa.) Forge and Iron Company is putting into its blacksmith shop a large steam hammer from Bement, Miles & Co. The works are running full on railroad axles and forgings.

Owing to an increase of business, Matthews Bros., Belfast, Maine, manufacturers of sash, doors and blinds, and every variety of housework finish, will replace their old engine with one of 100 horse-power.

The contract for building the new yarn mill of the Cohannet Corporation at Taunton, Mass., has been given out. The buildings are to be of brick; the main building 107x426 feet. An engine and boiler-room will be built.

The Stark Manufacturing Company, St. Louis, Mo., has purchased the extensive plant—out of use—of the St. Louis Malleable Iron Works. The Stark Company will make malleable iron, also nut locks, cable road yokes, etc.

A. T. Koopman, fine tools and artisans' supplies, Chicago, Ill., is succeeded by A. T. Koopman & Co., who will continue the business with double the capital formerly employed. A further increase of capital and facilities is talked of.

The large simple condensing engine of the New Bedford (Mass.) Manufacturing Company is being compounded, and, in order to keep up the regular shipment of goods, the mills are being run nights until 12 o'clock, and will continue until the change is completed.

William Glover & Co., of New Castle, Pa., have bought two acres of ground in that town, and will at once begin the erection of a large foundry and machine shop. Mr. Glover is at present foreman of the foundry department of James P. Witherow's works in New Castle.

Geo. Green, of Belfast, Me., has for some time run a wood-working establishment in that city, doing local work mainly. He has now associated with him his brother, Fred Green, and the work will be prosecuted on a more extensive scale, looking for Western orders.

Wathey, Brother & Son Empire Foundry Company is the name of a new firm in Cleveland, Ohio. They will at present make castings up to 3,000 pounds weight, but expect to be able to handle heavier work soon. One of the members of the firm is known to our readers as a writer on foundry matters.

The Schoen Manufacturing Company is removing its works from Philadelphia to Allegheny, Pa., where there is being erected a building for manufacturing purposes, 180 feet in length by 90 feet in width, with adjoining boiler and supply sheds. This company manufactures a new line of pressed steel goods for freight and passenger cars, consisting of pressed steel center plates, stoke pockets, and other articles used in car building, to take the place of cast-iron articles. These pressed steel goods greatly lighten the dead weight of a car, besides being, it is claimed, more durable than cast or wrought-iron.

Machinists' Supplies and Iron.

NEW YORK, March 22, 1890.

Iron—American Pig.—The market continues dull and prices tend downwards. We quote standard brands No. 1 X Foundry, $19 to $19.50; No. 2, $18 to $18.50. Grey Forge, $16.50 to $17. Southern irons have sold at $18.25 to $18.50 for No. 1 X Foundry, and $18 to $18.25 for No. 2.

✻WANTED✻

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Wanted—Good machinists; also a few exp'd scrapers. The Pond Machine Tool Co., Plainfield, N. J.

An experienced mechanical draftsman wants a position. C. V. H., AMERICAN MACHINIST.

Moulder—A thoroughly competent brass moulder wanted; one who is accustomed to small work, and understands the mixing of metals. L.M.P., AM.MACH.

A pattern maker exp'd in engine and machine work desires a change; good draftsman, thoroughly understands care of wood-working mach'y. A 1 references. Address X. Y., AMERICAN MACHINIST.

Wanted—Ass't mechanical draftsman; a young German with technical education preferred. Good inducements to the right party. R. H. T., AM.MACH.

Wanted—Position as foreman of machine shop in the vicinity of N.Y. Exp'd in marine, stationary engines and gen'l machinery. Hustler, AM. MACH.

Wanted—Half a dozen first-class machinists on piece-work. Steady work, new tools, and liberal prices. Location, Western Pennsylvania. Apply to "W.," care AMERICAN MACHINIST.

Machinists Wanted—First-class vise and machine hands of good habits can find steady employment and liberal wages. Address Morgan Engineering Company, Alliance, Ohio.

Wanted—Position as supt. or manager; 10 years' exp. handling help and producing goods at low figures; practically conversant with iron and brass founding, and machine work. Willing to base compensation on results. Supt., Care AM. MACHINIST.

I would like to hear from parties who desire to engage the services of a capable mechanic exp'd in designing and building machinery and tools; would take position as supt. or draftsman; satisfactory references given as to character and ability. H., Care of W. R. Cochrane, 225 E. 12th St., N. Y.

Wanted—Two first-class machinists; one acquainted with milling machine work, and able to keep his own cutters in order; the other a good scraper and fitter. To first-class men first-class wages will be paid. Answer, stating qualifications & price, Cycloidal Eng. & Pump Co., Keokuk, Iowa.

✢ MISCELLANEOUS WANTS ✢

Advertisements will be inserted under this head at 35 cents per line, each insertion.

Cheap 2d h'd Lathes & Drills. S. M. York, Clev'd, O.

Koopman's Scales for quick measurements.

Just out; aluminum-steel hack-saws, hard but not brittle. Crescent Mfg. Co., Cleveland, Ohio.

New catalogue of engineers' specialties free. Crescent Mfg. Co., Cleveland, O.

Light and fine machinery to order; Foot Lathe. Catalogue for stamp. E. O. Chase, Newark, N. J.

Turned and Higly Polished Iron and Steel Shafting a specialty. Merwin McKaig, Cumberland, Md.

Complete list of our Scales and other new tools for 2c. stamp. A. T. Koopman, Chicago.

Castings of every description and machinery built. Address Cedar Point Foundry, Port Henry, N. Y.

For Sale or Exchange—9 volumes AMERICAN MACHINIST, bound. S. H., 222 2nd st., Des Moines, Ia.

Inventions perfected; experimental work; fine tools, dies & light mach'y. C. Wadsworth, 90 Fulton st., N.Y.

For Sale—One heavy Hewes & Phillips Planer, 32"x32"x8 ft., in good order and repair. Address Capitol Mfg. Co., Chicago, Ill.

Engineers wanted to send their addresses and receive free a 25 cent book, "Hints and Suggestions for Steam Users." Lord & Co., P. O. Box 1262, Phila., Pa.

Inventions or improvements in measuring instruments & other fine tools wanted to manufacture & sell on royalty. "Tools," AMERICAN MACHINIST.

Simonsen-Walter Mfg. Co., Jefferson City, Mo., with modern foundry, machine and wood-work plant, wants spec. to manuf. for Western trade

Wanted—A first-class shaper, about 24-inch stroke, with all modern improvements. Address The Nail City Lantern Company, Wheeling, W. Va.

Wanted—To buy second-hand lathes, planers and shapers of all sizes. Must be cheap and in good order. Fosdick & Plucker, 6th and Culvert Streets, Cincinnati, O.

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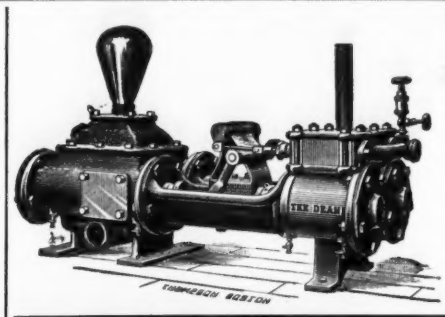
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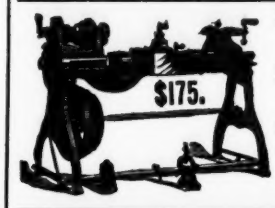

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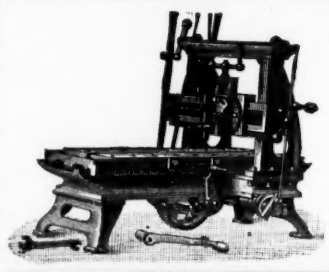
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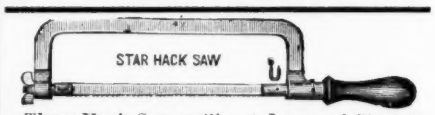

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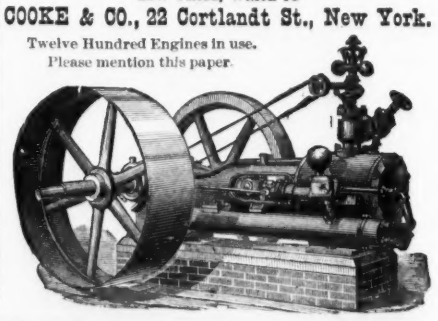

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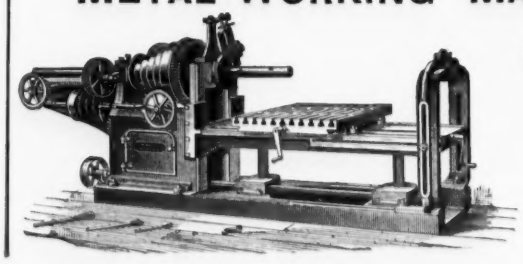

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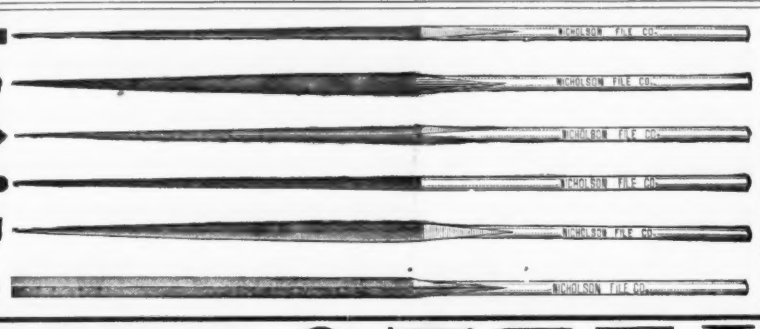

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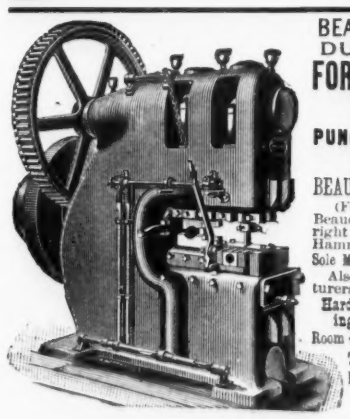

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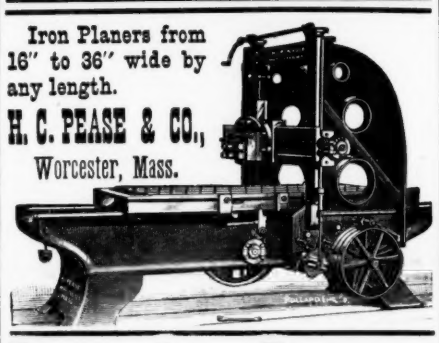

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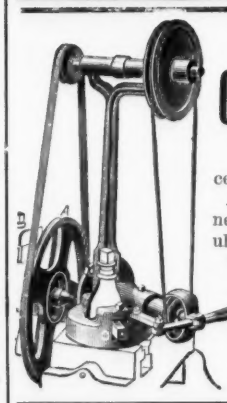

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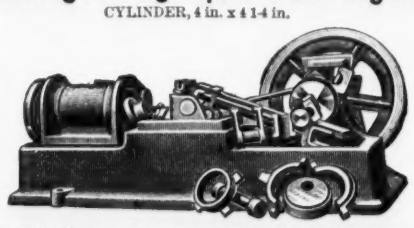

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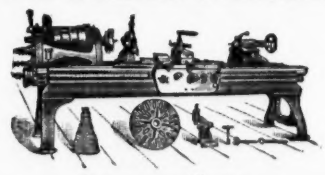

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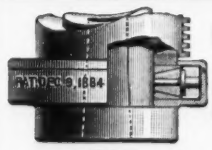

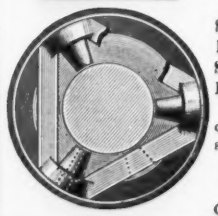

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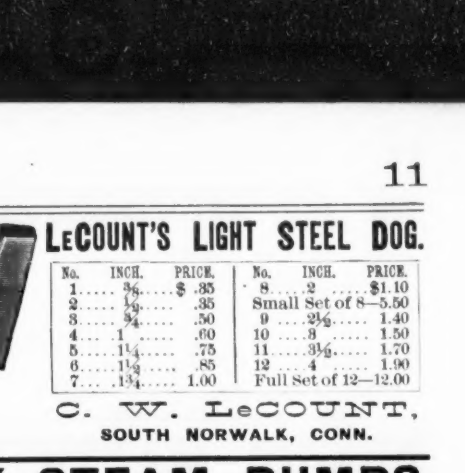

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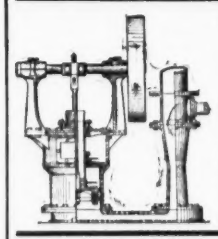

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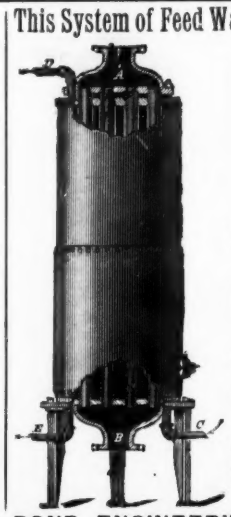

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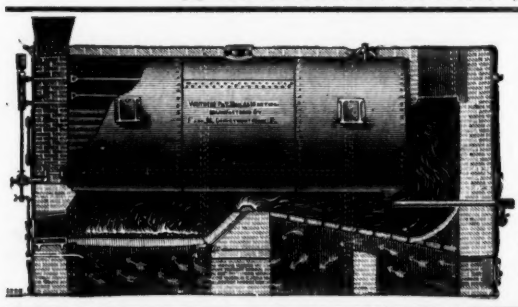

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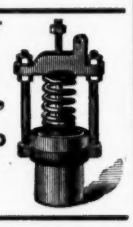

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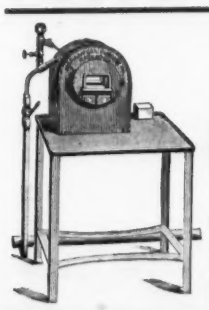

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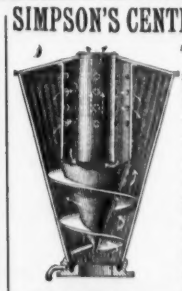

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16 in.	18 in.
18 1-2 in.	21 1-2 in.
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24 in.	30 in.
30 in.	36 in.
36 in.	43 in.

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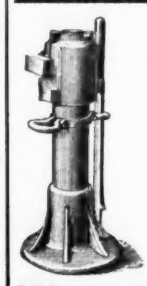

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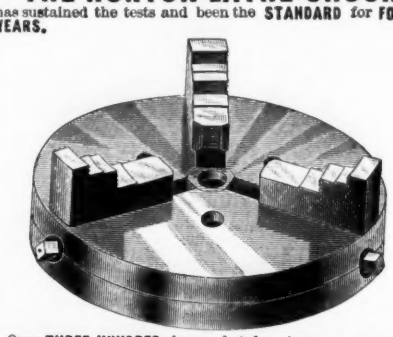

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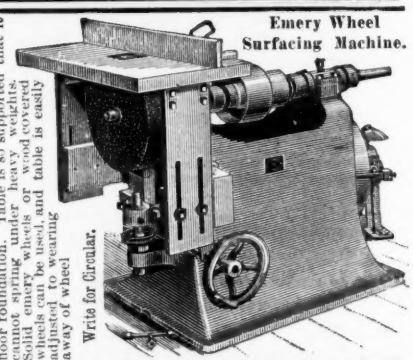

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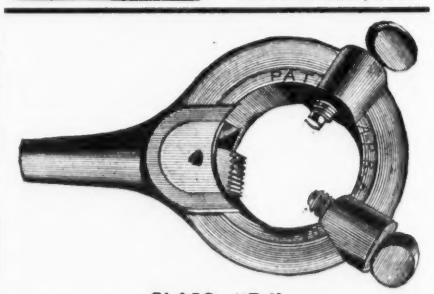

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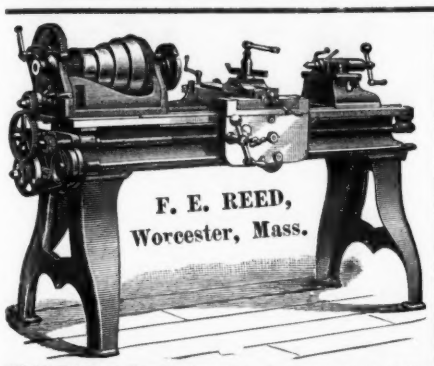

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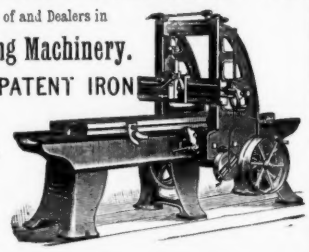

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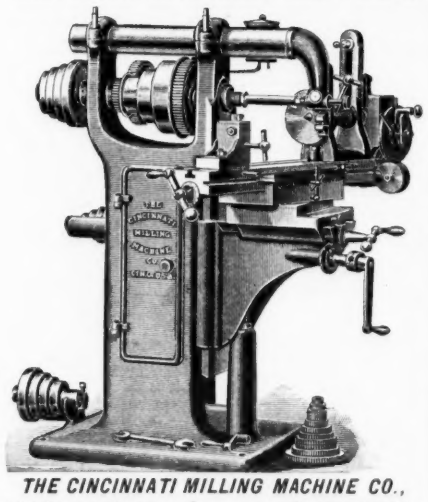

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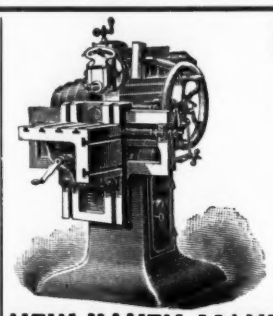

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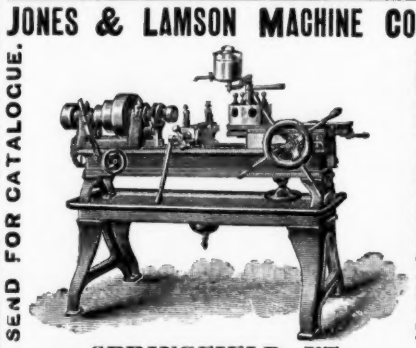

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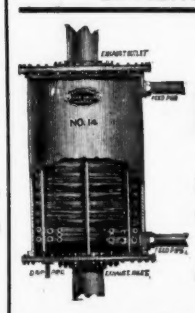

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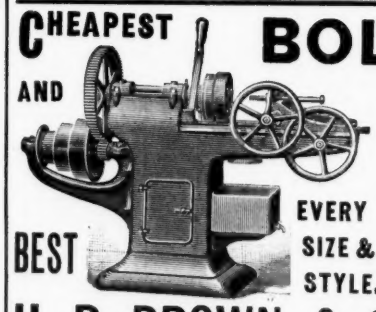

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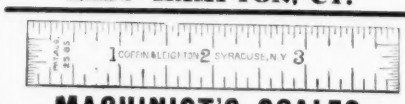

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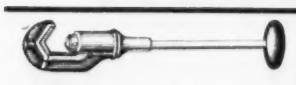

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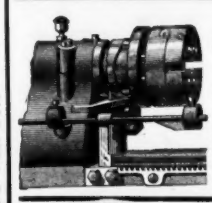

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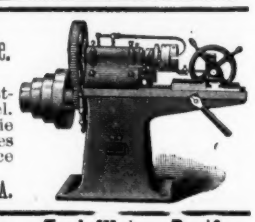

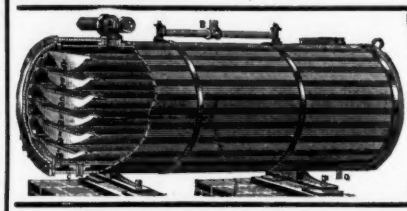

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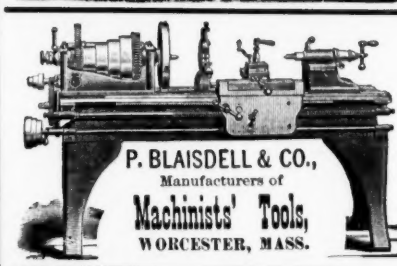

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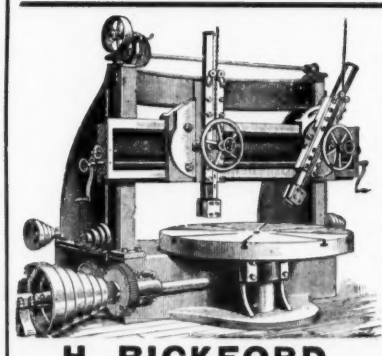

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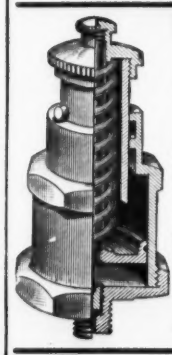

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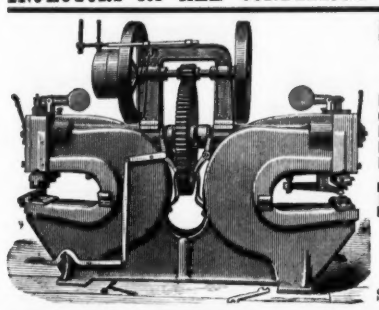

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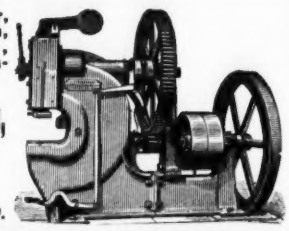
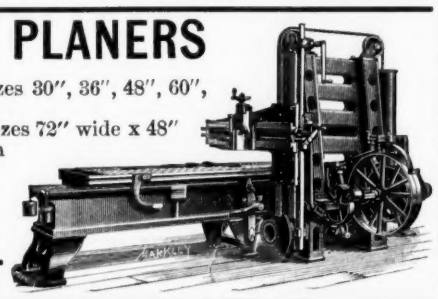


THE OPEN-SIDE IRON PLANERS
STANDARD OPEN-SIDE PLANER, Sizes 30″, 36″, 48″, 60″, by any desired length.
OPEN-SIDE EXTENSION PLANERS, Sizes 72″ wide x 48″ high x 10′ long, up to 120″ wide x 72″ high x 20′ long.
Open-Side Frog and Switch Planers.
Extra Heavy and Powerfully Geared Up.
The DETRICK & HARVEY MACHINE CO.
BALTIMORE, MD.



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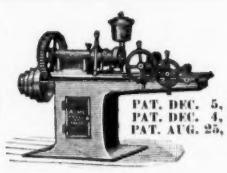
CLEVELAND, OHIO.
Manufacturers of
ACME BOLT & RIVET HEADERS,
Acme Single & Double Automatic BOLTCUTTERS.
Cutting from 1-8 in. to 6 in. diameter.
Also SEPARATE HEADS and DIES.
FIRST PREMIUM, CINCINNATI CENTENNIAL.



PAT. DEC. 5, 1882.
PAT. DEC. 4, 1883.
PAT. AUG. 25, 1885.

NICHOLSON & WATERMAN M'F'G CO.,
PROVIDENCE, R. I.
LATHES.
CUTTING-OFF MACHINES,
TRAVERSE DRILLS,
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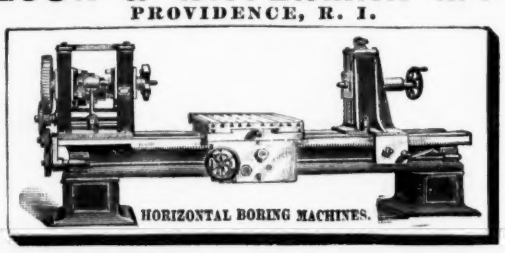
SPECIALS,
&c., &c.



HORIZONTAL BORING MACHINES.

BOLT & NUT MACHINERY.
BROACHING MACHINES,
FACING MACHINES,
BOLT LATHES,
STAY BOLT THREADERS,
&c., &c.

European and U. S. Patent Office
Of G. DITTMAR, C. E. Established 1877.
Offices { Washington Branch, 615 Seventh St., N. W.
Germany, Hornstrasse 11 in Berlin (Prussia.)
France (main office) rue Rochechouart 47 Paris.
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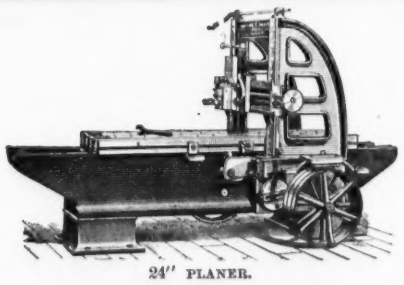

24″ PLANER.
IMPROVED 24 INCH IRON PLANER.
☞ Note the following features.
☞ Extra deep beds.
☞ Extra heavy housings.
☞ Extra wide gearing.
☞ Extra deep tables.
☞ Extra heavy Cabinet legs.
☞ Planers reversed from both sides.
☞ All feeds handled from both sides.
☞ Sleeves for bearings driven entire length solidly into bed.
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☞ 32″ and 36″ Planers in process of construction.
☞ Write for price with cuts and descriptions.
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68 & 70 SOUTH CANAL ST.,
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Bolt and Nut Machinery.
12 Sizes of National Bolt Cutters.
6 Sizes and Styles of Rapid Bolt Cutters.
5 Sizes and Styles of Bolt Pointers.
15 Sizes and Styles of Bolt Headers.
12 Sizes and Styles of Nut Machines.
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Also large variety of Tools in this line, making complete outfits for Bolt Shops. Catalogue sent on application. Apply to
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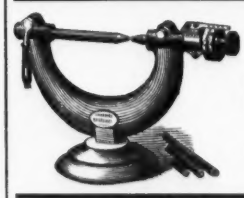

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The only micrometer that will not lose its accuracy by wear.
Satisfaction Guaranteed.
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BUILDERS OF IMPROVED
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Embraces nearly 400 Machines for
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Variety and Universal
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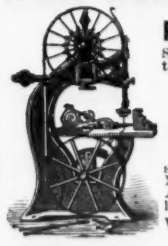
Band, Scroll and Circular Saws, Resawing Machines, Spoke and Wheel Machinery, Shafting, Pulleys, etc. All of the highest standard of excellence.
W. H. DOANE, Pres. D. L. LYON, Sec'y.



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BOILERS.
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STEAM HAMMERS.
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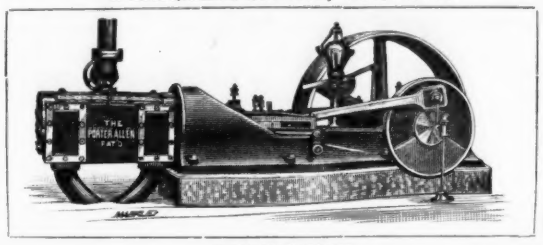

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SOLE MAKERS OF
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HIGH ECONOMY. DURABILITY. CLOSE REGULATION.

BEMENT, MILES & CO.,
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—BUILDERS OF—
METAL-WORKING MACHINE TOOLS
FOR
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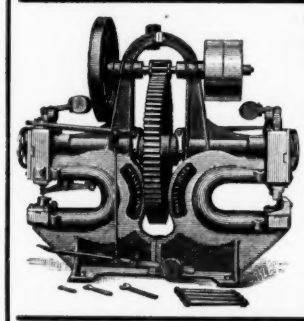

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MANUFACTURERS OF
PUNCHES AND SHEARS,
All Designs and Sizes,
AND A FULL LINE OF
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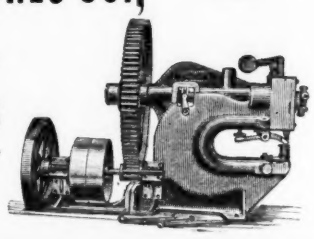
FOR
Boiler Makers, Bridge Builders, Ship Builders, Railroad Shops, Locomotive and Car Builders, etc., etc.



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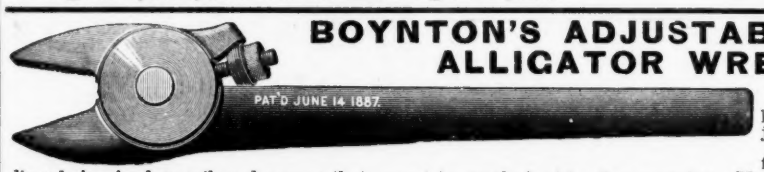
FORGING AND WELDING BY PETROLEUM AIR BLAST.
ALL OIL BELOW BURNERS! NO SMOKE, DIRT, OR ASHES!
Represented by WILLIAM PICKETT, SON & CO., 170 Lake St., Chicago; W. S. COLLINS, 171 Broadway, New York. CHILION JONES, Gananoque, Can. G. M. SMITH, Los Angeles, Cal. KALAMAZOO SPRING AND AXLE CO., Kalamazoo, Mich. C. S. BARROWS, 46 Wade Building, Cleveland, Ohio. GILBERT & BARKER MFG. CO., General Agents for the United States, Springfield, New York and Boston.
Sept. 29, 1885. July 5, 1887. Feb. 5, 1889. July 23, 1889.
☞ We will replace in Stock or Mutual Companies any Insurance canceled on account of using this System, when installed according to our plans.



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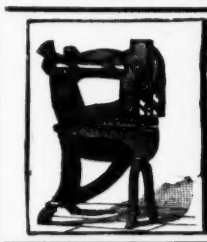
PAT'D JUNE 14 1887.
Quick and handy in adjustment. Invaluable for work on clipped pipe, in close coils and corners that cannot be reached with other wrenches. Made entirely of drop forged steel. Six sizes.
CAMPBELL PRINTING PRESS AND MFG. CO., MFRS.
160 WILLIAM ST., NEW YORK. 325 DEARBORN ST., CHICAGO.



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Rough and finished to order. All kinds of castings in green or dry sand and loam. Large variety of gear and pulley patterns. Soft castings for finishing. *Patterns made to order.* Parties requiring work are invited to correspond with us before buying elsewhere. Estimates submitted on application.
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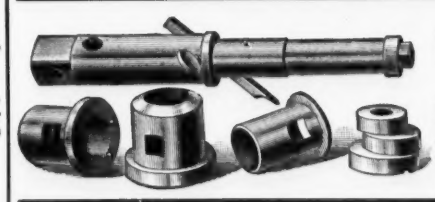

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Vance Lightning Flue Cutter
For removing Flues from Locomotive and Stationary Boilers. One man can cut five hundred (one end) in a day. In use in the leading Railroad Shops of the country. Combination Cutter for removing 2 in., 2 1-4 in., 2 1-2 in. and 3 in. Flues, $50. Sent on approval to Railroad Co.'s. Liberal Discounts to the Trade.
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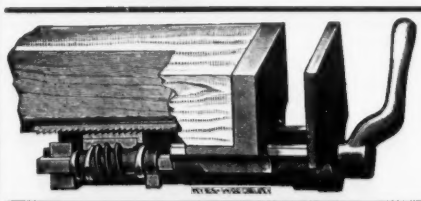

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For Pattern Makers and Wood Workers.
WYMAN & GORDON,
WORCESTER, MASS.
DROP FORGINGS.

BALL AUTOMATIC CUT-OFF ENGINES,
ERIE, PA.
The characteristics of these Engines are Beauty of Design, Superior Finish, Limited Feet in Space required, Economy of Fuel, Perfection of Regulation.
CHARLES R. VINCENT & CO.,
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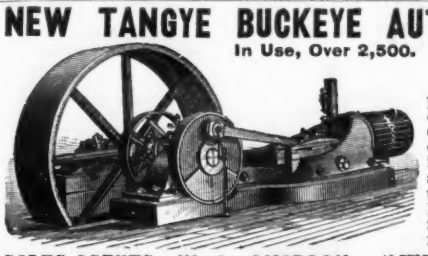
NEW TANGYE BUCKEYE AUTOMATIC CUT-OFF ENGINES.

In Use, Over 2,500.

25 to 1,000 H. P.



These engines are the combined result of long experience with automatic cut-off regulation, and most careful revision of all details. They are designed and constructed for heavy and continuous duty at medium or high rotative speeds. Highest attainable Economy in Steam Consumption and superior regulation guaranteed. Self-contained Automatic Cut-off Engines 12 to 100 H. P. for driving Dynamo Machines *a specialty*. Illustrated Circulars, with various data as to practical Steam Engine Construction and performance, free by mail. **Address, BUCKEYE ENGINE CO., Salem, Ohio.**

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Sole Licensees and Manufacturers for New Jersey (South of Trenton), Eastern Pennsylvania, Delaware, Maryland and Virginia.

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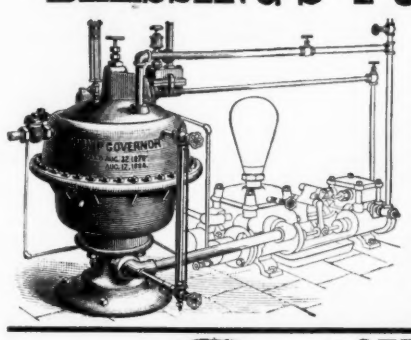

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ALBANY STEAM TRAP CO., Albany, N. Y.

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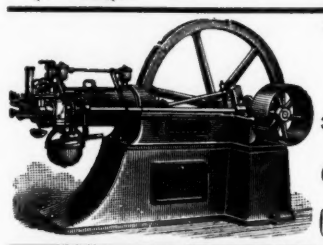

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33d and Walnut Sts., PHILADELPHIA. Branch Office, 151 Monroe St., CHICAGO.

OVER 25,000 ENGINES IN USE.

GUARANTEED To consume 25 to 75 Per Cent. Less Gas than ANY Other Gas Engine doing the same work

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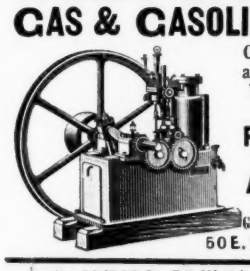

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For Separating and Removing Entrained Water from Live Steam;

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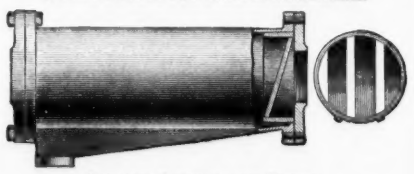

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15-in Friction Shaper, Hendey.	"
12, 15, 22 and 15 in. Crank Shaper, Juengst.	New.
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24 in. Bridgeport Shaper, 2d hand.	A 1.
24-in. Shaper, Bridgeport.	New.
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7 and 11 in. swing Hand Lathes.	New
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16 in. x 6 and 8 ft. Engine Lathe, McMahon.	New.
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16-20, 20 and 24 in. Engine Lathe, Bridgeport.	
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Ames Index Milling Machine.	Fair.
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1 No. 37 E. W. Bliss Co. Power Press,	A 1 order.

Cold Rolled Shafting in stock, all sizes.

Full line of new Machinery. Write for what you want.

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UNIVERSAL RADIAL RADIAL DRILLING MACHINES

THREE DESIGNS. SIX SIZES

EMBODY ALL DESIRABLE FEATURES

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25 Different Styles and Sizes.

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NEW AND IMPROVED MILLING MACHINE.

☞ Note the following new features:

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☞ Sleeve for the overhanging arm and the column cast in one piece.

☞ All movements operated from front of machine instead of under the table.

☞ Long bearings. Long and wide tables.

☞ Power feed entire length of table.

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☞ Indexed feeds on all machines.

☞ Large cones, wide belts.

☞ Each machine furnished with a vise.

☞ Built either plain, back geared or universal.

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MANUFACTURERS OF IMPROVED CORLISS STEAM ENGINES IN FULL VARIETY.

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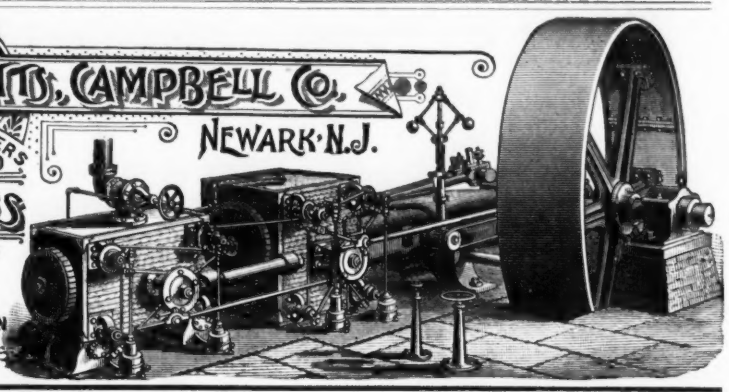
CONTRACTS TAKEN FOR COMPLETE POWER PLANTS



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NON-CONDENSING, CONDENSING COMPOUND.

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ICE-MAKING AND REFRIGERATING MACHINERY.

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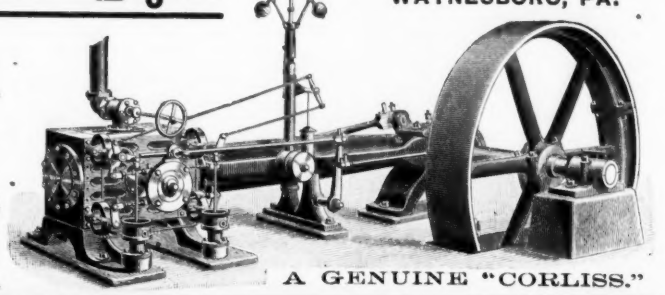

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Are tested under full load before shipment.

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IN STOCK FOR QUICK DELIVERY.

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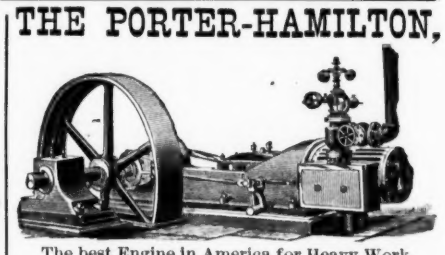
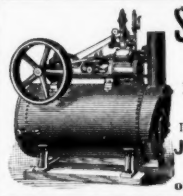


The best Engine in America for Heavy Work.

WILLIAM TOD & CO.,

Youngstown, Ohio.

STEAM ENGINES



Upright and Horizontal, Stationary, Portable and Semi-Portable.

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STEARNS M'F'G CO.

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ENGINES from 15 to 400 Horse Power

Boilers of Steel and Iron supplied to the trade or the user. Send for Catalogue.

SAW MILLS and GENERAL MACHINERY

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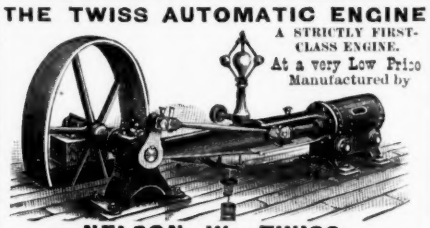
THE TWISS AUTOMATIC ENGINE

A STRICTLY FIRST-CLASS ENGINE. At a very Low Price Manufactured by



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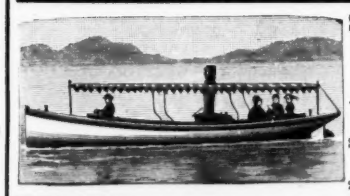

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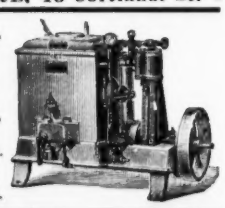

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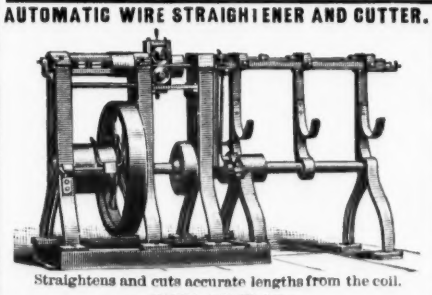

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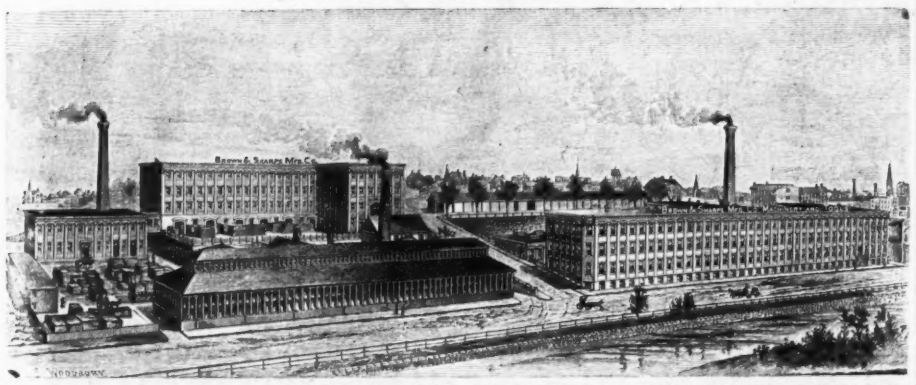

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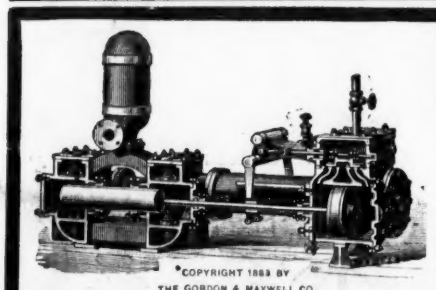

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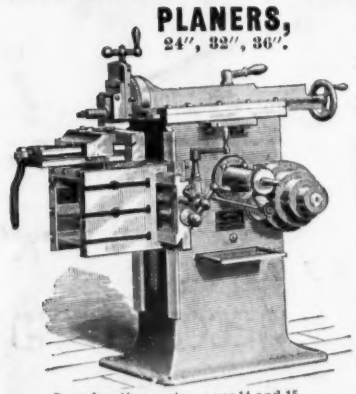

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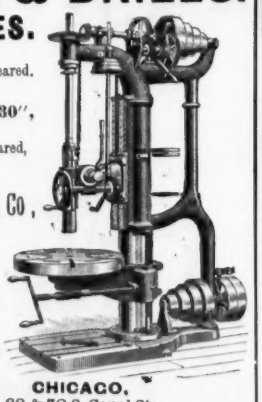

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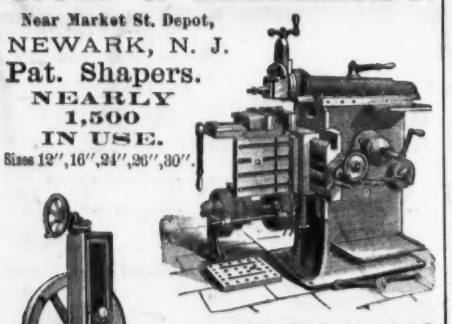

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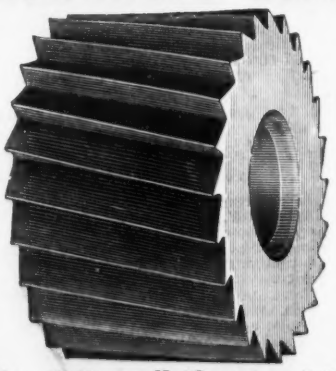

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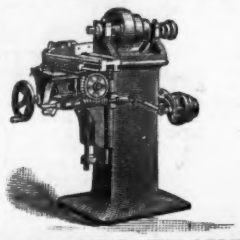

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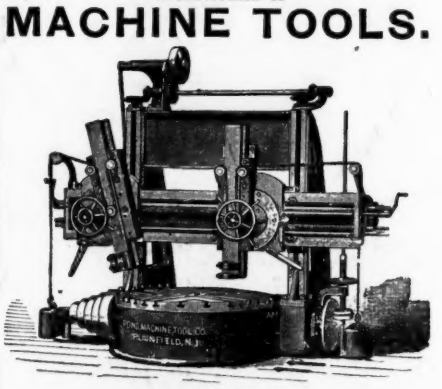

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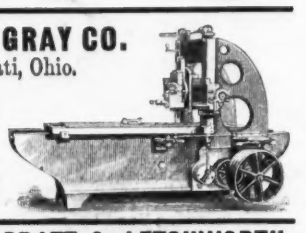

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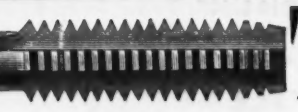

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